TAXOMORPHOLOGICAL STUDIES OF DIGENETIC PARASITES OF CERTAIN FISHES OF BETWA AND KEN RIVERS OF BUNDELKHAND REGION

THESIS

SUBMITTED FOR THE AWARD OF THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN

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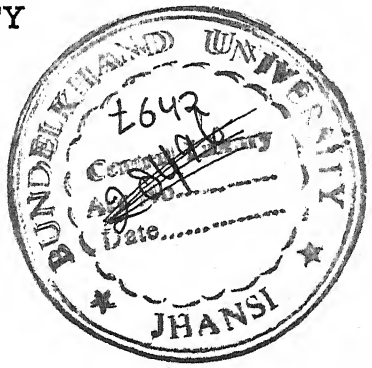
UNDER THE FACULTY OF SCIENCE

OF THE

BUNDELKHAND UNIVERSITY

JHANSI



BY

RAHBAR SULTAN

M.Sc.

P. G. DEPARTMENT OF ZOOLOGY

BIPIN BEHARI (P. G.) COLLEGE

JHANSI

NOVEMBER, 1996

DR. U.K. DWIVEDI,
M.Sc., Ph.D.
READER

P.G. Department of Zoology
Bipin Behari (P.G) College
JHANSI.

Dated: 28 November, 1996

CERTIFICATE

Certified that the thesis entitled, "Taxomorphological Studies of Digenetic Parasites of certain Fishes of Betwa and Ken Rivers of Bundelkhand Region", submitted by Mr.Rahbar Sultan, M.Sc. (Zoology) for the degree of DOCTOR OF PHILOSOPHY (Ph.D) in the subject Zoology under the Faculty of Science of the Bundelkhand University, Jhansi, embodies the original work done by him. He has worked under my guidance and supervision for more than twenty four months, commencing from the date of his registration.

It is further certified that the candidate has put in an attendance of over 200 days in this department from the date of his registration for the Ph.D. degree of the Bundelkhand University as required under relevant ordinances.

(U.K. DWIVEDI)
Supervisor

A C K N O W L E D G E M E N T S

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(RAHBAR SULTAN)

Jhansi
Nov. 28, 1996

C O N T E N T S

PART III

LARVAL TREMATODES

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PART I - GENERAL

INTRODUCTION

Due to compelling economic reasons the fish farming is developing fast into a major profitable industry. In India over 7.5 million people depend on fish and fishery for their livelihood, while 23,000 are engaged in ancillary vocations such as basket and ice-making, fish processing and transport etc. (Pandey, 1977). The importance of fish as an efficient food converter, as compared to other conventional terrestrial farm livestock has been stressed by Jolly (1978) who has reported that some strains of fishes take less than 2 gm of food to add 1 gm. to their own body weight. The fish fauna constituting one of the most important economic groups, responsible for providing much needed animal protein to the hungary millions, is also rich source of many medicinal and industrial oils, fish meals, insulin, minerals, vitamin A and B, and B-Complex and many protolytic enzymes. Besides these,numerous industrial products are manufactured from different organs of fish. Imitation pearls, foam producing extinguishers and active carbon are made from the fish scales. Isinglaso and many other adhesives are made from the swim bladders. Leather, gelatin, glue, histamine, guanine and cystine are also derived from the fish waste.

The fresh water fishes contain 54-82% moisture and oils, 13.5 - 25.2% proteins, 1 - 2% minerals and about 1% other

constituents. The fish protein occupies an important place in human nutrition as it has high digestibility and biological and growth promoting value. Such proteins are balanced well with respect to essential amino acids and are comparable with other proteins of animal origin. The protein of certain fish species is reasonably rich in lysin and mothiomine contents. Studies in the growth of rats have proved that fish proteins are somewhat superior to egg albumen, beef protein and casein and are of the same class as Chicken (Anon, 1962). The mineral constituents of fish museles include almost all essential elements like calcium, magnesium, potassium, phosphorus, sulphur, copper, manganese, strontium, zinc, vanadium bismith, silver, cobalt, mercury, aluminium, barium, lead, molybdeum, nickel, titanium, chromium, nibium, boron, lithium, antimony, silicon, bromino, fluorine and iodine. Cadmium and gold have also been reported from some species.

The environment of fish covers more than 70% of this planet. Realising the great economic potential in regard to a good source of animal protein and other benefits of fish production, Government of India and other State Governments have launched many schemes for the brisk development of this industry. Proposals for adopting composite culture technology to provide adequate protein food to rural masses and additional job opportunities to the poor fisherman communities are also being considered. According to recent estimates (Anon, 1979)

a seven-fold increase in fish production is possible through this technology. There are enormous fresh-water sources in the form of vast river systems, their tributaries, streams, lakes, reservoirs, tanks, ponds and paddy fields for indigenous fisheries in India. It has been estimated that the total length of principal rivers and their tributaries is C 27,360 Km. and nearly C 1, 12, 650 Km. area is under the canals and other such irrigation channels. Besides this, the total area of fresh water ponds and tanks of our country is about 1.6 million hectares.

For a successful exploitation of the vast fish resources a properly managed and scientifically based fisheries development programme is essential. Fish-like other animals are prone to a number of diseases which are responsible for heavy losses due to mortality and morbidity. Therefore, a proper understanding of the fish diseases is a prequisite for achieving healthy fish farming to ensure high yields. Among the various parasitic diseases of fish helminths form a major group. Among all the known helminthic parasites of fishes in India, according to Chauhan (1963), trematode parasites constitute the largest group which has attracted the greatest attention of scientists. The significance of trematode parasites among the fishes can very well be understood through the work of Klass (1963) who after an ecological survey of metacercariac of a single trematode parasite Clinostomum marginatum warned that future fisheries management of U.S.A.

will be adversely hit if this parasite is not controlled. In view of high prevalence and intensity of trematode parasites among Indian fresh-water fishes Malberg (1975) has warned against introduction or import of Indian fishes in U.S.A. Besides, substantially cutting the economic gains from the fishes by impairing their health, the trematode parasites are responsible for many zoonotic diseases of man and animals through the fish which act as a transport or intermediate host. These parasites exert harmful effects on the health of fishes in a variety of ways. Cross (1933) showed that parasitic infestation tends to decrease the growth rate resulting in stunting of fish. Kawai (1937) reported that Clonorhis Sinensis causes jaundice, decrease in blood sugar and pathological changes in liver of experimentally infected animals. In experimental infection Hunter and Hunter (1938) found that in small mouth - black - bass fingerlings strigeid metacercaria caused a significant loss of weight resulting in emaciation of fishes. Volf (1953) has listed many gill and eye diseases of fresh-water fishes caused by trematode parasites. Parasitic castration has been reported by Izyumova (1964) and Korr (1948). The yield of fish products like liver oils is affected due to the damage to liver tissue during heavy infestation. After survey of Indian fish-parasites Tripathi (1959) opined that helminthic infections, when heavy, could constitute a major factor in morbidity and even mortality of fishes. Parasitic infection

recorded by him was 64.95% in pond fishes. In a brief survey of helminth parasites of Uttar Pradesh Rai (1966) found that 21 species of fresh water fishes were infected with 10 adult and 11 larval trematode parasites which damage different vital organs like liver, alimentary canal and urinary bladder. Srivastava et al. (1975) found the helminthic infections, in three reservoirs of U.P., was 20 - 60%.

Fish born zoonosis is more significant specially in case of trematode parasites which involve many hosts for completion of their complex life cycles. Witenberg (1932) has listed 14 species of trematodes transmitted to man through eating uncooked fish in Palestine. Mauror (1969) and Nealy (1970) have also reported many species of fishes that act as carriers in human trematode infections. Lamcy et al. (1976) have reported a case of a French Professor who acquired infection of Metagonimus yokogawai by frequently eating raw fish during his visit to Japan.

Trematode parasites cause numerous diseases in fishes and other economically important animals. The common mode of transmission of infection is the transport of metacercarial/ cercarial forms that usually become encysted in the liver, sub-cutaneous museles and mesentery of intestine and other vital organs or underneath the scales, fins, operculum and nictitating membrane or gill-membrane of fishes. Such fish

with encysted stages, when eaten by a definitive host infection sets in and further development of the parasite is ensured. Wright (1947) incriminated 49 species of trematodes responsible for fish-born zoonosis. Similar information from our country is scanty as only a few workers have explored this aspect. Noteworthy contributions are those of Bhalerao (1932), Gupta and Pande (1963), Rai and Pande (165), Rai (1966 b, 1969 and 1976), Ansari (1968), Sastry and Patnaik (1968), Sahai (1969), Prasad and Mohan (1970) Sahai and Srivastava (1971) Pande and Shukla (1974), Madhavi (1978) etc.

Since then numerous publications on both monogenetic and digenetic trematodes of fresh water fishes of India, have contributed dealing mainly with the taxonomy and morphological studies. The systematic and taxonomic position of many Indian forms is also not satisfactory as a number of genera and species have been raised on insufficient material without any consideration of wide range of morphological variations which is a common feature in this group. Recent studies of Vinod Agrawal, P. Rai, S.P. Gupta, D.N. Fotedar, K.C. Pandey and their co-workers etc. have amply proved this point. Several of these forms need re-examination through sufficient material and observations on the biology. Beside this, the parasitism is reported to have brought about behavioural influence in fishes in some cases.

Srivastava (1975) opined that the number of intermediate hosts involved is one of the important biological factors, among others, for the determination of fish parasitism in any confined body of water.

With the above background in mind, the present study was undertaken. The observations embodied in the thesis are based on the study of material gathered from extensive survey of digenetic trematodes from Betwa and Ken rivers passing through the Bundelkhand region only.

Bundelkhand region is considered to be a premier region of the country, because it has a number of small and large water bodies, lakes, dams and two rivers which provide better fisheries and aquaculture prospects. All these water bodies are rich in fish fauna.

The Bundelkhand region forms South-east boundry of Uttar Pradesh, extending from 24.21' to 26.42' North latitude and 78.14' to 81.38' East longitude. It is comprised of five districts, namely - Jhansi, Lalitpur, Jalaun, Hamirpur and Banda. The region is surrounded in northern side by the districts of Etawah, Kanpur, Fatehpur and Allahabad of Uttar Pradesh; in Western side by the districts of Guna, Shivpuri and Datia of Madhya Pradesh, and in Southern side by the Districts of Sagar, Chattarpur, Panna of Madhya Pradesh.

The Betwa and Ken are only two major rivers of this region which extend from one end of Bundelkhand region to other. These rivers are very vast in which water remains throughout the year. It is also a fact that numerous dams, reservoirs are also made on these two rivers in different parts of the region, which are a good source of inland fisheries. All popular groups of fishes such as major carps, cat fishes, live fishes, feather backs, sheet fishes eels etc. form the bulk of total production of this region.

Thus, efforts have been made to concentrate the work on these host fishes and to obtain maximum number of parasites from them throughout the period of study. The attempt has been made to fill a part of the wide lacuna left on the studies of digenetic trematodes of fishes of Betwa and Ken rivers of Bundelkhand region.

The thesis incorporates the detailed taxomorphological description of 18 species of trematodes, including 11 new forms, belonging to Order Digenia. Beside it, a few digenetic larval forms also have been described including three new forms. The validity of certain species has been discussed.

Among digenetic trematodies 18 species, belonging to 11 genera and 8 families, have been described in detail. The new species described in this thesis are eleven. Beside it

the validity of the genus Haplorchoides Chen, 1949 and Haplorchis Looss, 1899 has been discussed in detail under the heading "On the validity of Haplorchinae flukes from Indian Siluroid fishes".

Besides, the morphological variations met within Astitrema reniferum and haplorchine trematodes (Haplorchis attenuatus and H. Piscicola) are discussed and illustrated.

Under the second section certain larval digenetic trematodes have been described including three new forms viz. Bucephalus prasadi, Diplostomulum lalitpurensis , and Prohimistomulum umapatii.

The detailed study of Bucephalus prasadi n.sp. has been made. Its morphology, taxonomy and experimental development in one fish and a laboratory mammal has been given. Certain taxonomic changes and amendments in the diagnosis of certain families and genera have been suggested. In a few species key for the identification of species is also added.

In the last a complete BIBLIOGRAPHY and a SUMMARY of the thesis are also given.

HISTORICAL RESUME

HISTORICAL RESUME

Helminth parasites have been known to mankind since Vedic and post - Vedic periods around 800 B.C., as in Atharvaveda these worms are referred to as Krimis. Great medical treatises of Charak and Susruta (between 200 B.C. and 200 A.D.) even mentioned detailed treatment of parasites. A detailed account of knowledge of these worms in ancient India is given by Bhaduri, Tiwari and Biswas (1972).

Our present day knowledge of helminth parasites dates back to 1379, when Jehan - de - Brie (1379) who for the first time discovered fluke Fasciola. The first references to trematodes, probably Fasciola jacksoni and Pseudodiscus hawkesi, from Indian region in modern times is made by Gilchrist, who has worked on them in the years 1841 - 1846. Later on, cobbold (1869 - 1882) wrote a series of papers describing parasites of elephant, cattle and Gangetic dolphin and thus making the begining of the scientific study of trematode fauna of India.

Bhalerao (1926) was the first Indian helminthologist to give a boost to Indian helminthology in general and study of trematodes in particular. He was followed by a band of dedicated workers like Mehra, Verma, Moghe, Thapar, Lal,

Srivastava (H.D.), Chauhan, Pande and many others, who contributed much to our present day knowledge of the trematodes from Indian region. Bhalerao (1939) reviewed the progress of the knowledge of trematodes in India till that time. In 1956 Thapar and Chauhan(1963)also discussed the progress of helminthology in India with special reference to trematodes. Some of the more important contributions in this field include -

Bhalerao (1926,36), Verma (1927, 36), Chauhan (1940 , 49,54, 55); Srivastava, H.D. (1938, 48), Mehra H.R. (1935, 38, 62, 66); Pande (1937), Patwardhan (1935); Khan (1935); Mehra, R.K. (1941); Kaw (1950); Dayal (1948, 49,50); Baugh (1949, 50), Gupta (1950, 51, 55, 56); Jaiswal (1957), Jain (1967) and Pandey, K.C. (1970).

Helminth parasites of Indian fishes have not received the attention they deserve, except for the systematics of certain parasites. A persual of literature shows that following Indian workers have described the trematode parasites of Fishes -

Billet (1899) described Isoparorchis hypselobagri from Wallago attu and also immature forms of the some from Barbus tor, Channa striatus, Notopterus notopterus and Mastacembelus armatus from India.

Southwell (1913) described Isoparorchis trisimilitubis, which was later renamed as I . hypselobagri from the air bladder of wallago attu.Verma (1927) reported Opisthorchis pedicellata from the gall bladder of Rita rita. He (1935) also recorded gastorostomes from siluroid fishes.

A large number of workers have made substantial contribution on the taxonomy of trematode parasites. These include:-

Southwell and prashad (1918) described Clinostomum piscidium from Nandus nandus.

Verma (1927) described Opisthorchis pedicellata from Bagarius vattellii and Rita rita from Allahabad.

Thapar (1930) described Gomtia piscicola from Bagarius varrellii from Lucknow.

Srivastava, H.D. (1933) described Progonus piscicola and progonus ovocaudata from ophiocephalus punctatus; Ophiocorchis lobata and ophiocorchis singularis from Ophiocephalus striatus from Allahabad.

Pande (1934) described Orientocreadium indicum from Heteropneustes fossilis and Rita buchanani from Allahabad.

In (1937) he described Allocreadium handiai from Ophiocephalus punctatus. In (1938) he described Allocreadium kosia from Barbus chilinoides; Allocreadium schizothoracis from Schizothorax micropogon; Allocreadium mahaseri from Barbus tor from Allahabad.

Dayal (1949) described Phyllodistomum vachius from Eutropiichthys vacha from Lucknow and Allahabad.

Bhalerao (1941) described Clinostomum indicum from Notopterus notopterus from Allahabad. In (1942) he described Clinostomum dasi from Saccobranchus fossilis and Clinostomum prashadi from an unidentified fish from Hyderabad.

Mehra (1941) described Opisthorchis pedicellata minutus from Mystus seenghala and Wallago attu from Allahabad.

Gupta (1950) described Allocreadium thapari from Rita rita from Hardoi. In (1951) he described Phyllodistomum singhiai from Mastacembelus armatus from Lucknow and Saharanpur. In (1953) he described Haplorchoides seenghali from Macrones seenghala ; Phyllodistomum vittatusi from Macrones vittatus; Haplorchoides ritai, Haplorchoides brahamputraensis from Rita rita from Assam; Haplorchoides gomtioensis from Silundia gangetica from Lucknow.

In (1956) he described Allocreadium kamali from Chela bacaila, Allocreadium mehrai from Rhychobdella aculeata from Lucknow. In (1963) he described Allocreadium makundai from Barbus sarana from Banaras.

Gupta and Verma (1976 publ. 1977) described Allocreadium mrigali, Allocreadium baranai, Allocreadium saranai from Cirrhina mrigala, Barilius barana and Barbus sarana respectively.

Kaw (1950) described Allocreadium nemacheilus from Nemacheilus kashmirensis; Clinostomum schizothoroxi from Oreinus sinuatus, Schizothorax micropogon; phyllodistomum loossi from Schizothorax socinus from Kashmir.

Jaiswal (1957) described Phyllodistomum (Catroptoides) indianum from Heteropneustes fossilis and Phyllodistomum parorchium from Glossogobius (Gobius) giuris; Euclinostomum chanai from Ophiocephalus punctatus; Clinostomum macrosomium from Mastacembelus armatus from Hyderabad.

Saksena (1958) described Orientocreadium raipurensis, Orientocreadium dayali from Clarias batrachus; Allocreadium spindala from Mastacembelus armatus from Raipur. In (1960) he described Orientocreadium umadasi from Clarias batrachus from Raipur.

Srivastava, P.S. (1960) described Allocreadium ophiocephali from Ophiocephalus punctatus from Raipur.

Motwani and Srivastava (1961) described Phyllodistomum chauhani from Mystus tor and Mystus seenghala; Phyllodistomum tripathi from Bagarius bagarius from India.

Rai (1962) described Allocreadium dollfusi, Allocreadium singhi, Allocreadium hirnai from Barbus tor from the river Hiran, near Katangi and Sehora (M.P.).

Srivastava, C.B. (1961) described Pycnadena komiyai from Oxygaster gora from India.

Agrawal (1964) described Allocreadium heteropneustusius from Heteropneustes fossilis; Haplorchoides macroni from Macrones seenghala from Lucknow. In (1966) she described Genarchopsis punctati from ophiocephalus punctatus from Lucknow.

Kakaji (1969) described Genarchopsis cameroni from Mystus seenghala; Allocreadium catlai from Catla catla; Genarchopsis cuchiai from Amphipnous cuchia from Lucknow. In the same year, she described Allocreadium guptai and Allocreadium fasciatusi from Rita rita and Trichogaster fasciatus respectively, from Varanasi.

Fotedar (1969) described Phyllodistomum megacotyle from Garra mullya from Kashmir.

Pande, B.P. and Shukla, R.P. (1976) described Haplorchoides pearsoni and Haplorchoides mehrai from Channa punctatus and Mystus vittatus respectively from Lucknow.

Gupta, V. and Puri, M. (1979 publ. 1980) described Allocreadium Calbassii, Allocreadium manteri from Labeo calbasu, Anabas testudineus respectively from Lucknow.

In Madhya Pradesh also, lot of work was done at Jabalpur, Raipur, Rewa, Ujjain and Gwalior by Singh , Agarwal, Dwivedi, Rai, Saxena, Jain, Khoche, Johri, Dandotia and others. However little work has been done on the helminth parasites of fishes of Bundelkhand region.

From the foregoing account, it is evident that considerable progress is being made in the knowledge of helminth fauna and its taxonomic study of this country, but very little work has been done to ascertain the incidence of parasites and estimation of helminth infection.

The important contributions in this field have been made by Srivastava, C.B. and Mukherjee, G.D. 1986; Siddiqui, A.H.; Nizami, W.A. (1988) Devraj , M & Ranganathan, V. (1991); Bahaduria, S.(1992), Bhadauria, S & Dandotia, M.R. (1984, 1992, 1994) and others. Still a wide lacuna is left in this field considering the richness of fauna of helminth parasites.

MATERIAL AND METHODS

MATERIAL AND METHODS

The host fishes were collected mainly from the two rivers, namely Betwa and Ken, passing through the Bundelkhand region. The prominent collections were made in the districts of Jhansi, Lalitpur, Hamirpur and Banda. Beside these, the various dams made on Betwa river were also examined for the collection of host fishes. The fishes were also purchased from the local fish markets of Sipri and Raiganj Bazar and from certain fish sellers at Banda and Hamirpur. These fishes were a part of catch from the rivers Betwa or Ken.

The host fishes were kept alive in aquaris in the laboratory and then freshly killed, dissected and examined at convenience. A thorough search was done to determine the where-abouts of of parasites. Various organs particularly body cavity, stomach, duodenum, intestine, rectum, gall bladder and kidneys were carefully examined in petridish under low power binocular.

Soon after collection or recovery, the trematodes were thoroughly washed and kept in sline water. They were studied alive and observations were made regarding the colour and movements of body, spines on the body, oral and ventral suckers, cirrus and metraterm, excretory bladder and its branches.

For fixation of trematodes 5 - 10% formaline was used. For whole mounts, preservation in formalin for longer periods gave good results. For preparing whole mounts, precaution was taken to avoid over or under pressure.

For preparing whole mounts of trematodes, after fixation and thorough washing in water, worms were dehydrated and stained in Borax carmine, then cleared in xylene and finally mounted in DPX. The drawings of the whole mounts were made with the help of a camera lucida at a suitable magnification.

The fishes were examined at regular intervals from July 1993 to June 1996. A total of 1875 fishes belonging to different species available from Betwa and Ken rivers were collected and examined, and the trematodes procured from them were studied alive and after preparing whole stained mounts.

Only the species of trematodes which were either new to science or of any morphologic or taxonomic importance have been included in the thesis.

A SYSTEMATIC LIST OF THE HOSTS EXAMINED

A SYSTEMATIC LIST OF HOSTS EXAMINED

Below is given a systematic and composit list of fresh-water fishes found and examined in Betwa and Ken rivers in the Bundelkhand region. It contains 58 species belonging to 36 genera and 16 families of the fishes.

Order : CLUPEIFORMES

Family: CLUPEIDAE

1. Gudusia chapra (Hamilton)
2. Goniolosa manimina (Hamilton)
3. Corica Saborna (Hamilton)
4. Ilisha motius (Hamilton)

Family: NOTOPTERIDAE

5. Notopterus chitala (Hamilton)
6. Notopterus notopterus (Pallas)

Order : CYPRINIFORMES

Family: CYPRINIDAE

7. Oxygaster bacaila (Hamilton)
8. Barilius barila (Hamilton)
9. Barilius barna (Hamilton)
10. Barilius bendelisis (Hamilton)
11. Barilius bola (Hamilton)
12. Danio (Brachydanio) rerio (Hamilton)
13. Rasbora daniconius (Hamilton)

14. Aspidoparia morar (Hamilton)

15. Amblypharyngodon mola (Hamilton)

16. Puntius chagunio (Hamilton)

17. Puntius sarana (Hamilton)

18. Puntius sophore (Cuvier & Valenciennes)

19. Puntius ticto ticto (Hamilton)

20. Tor tor tor (Hamilton)

21. Labeo calbasu (Hamilton)

22. Labeo fimbriatus (Hamilton)

23. Labeo gonius (Hamilton)

24. Labeo rohita (Hamilton)

25. Cirrhinus mrigala (Hamilton)

26. Cirrhinus reba (Hamilton)

27. Catla catla (Hamilton)

28. Osteobrama cotio (Hamilton)

29. Crossocheilus latius latius (Hamilton)

Family: COBITIDAE

30. Noemacheilus botia (Hamilton)

31. Noemacheilus rupicola inglisi Hora

Family: BAGRIDAE

32. Mystus (Aorichthys) aor (Hamilton)

33. Mystus (Aorichthys) seenghala (Sykes)

34. Mystus (Mystus) bleekeri (Day)

35. Mystus (Mystus) cavasius (Hamilton)

36. Mystus (Mystus) vittatus (Bloch)

37. Rita rita (Hamilton)

Family: SCHILBEIDAE

38. Ailia coila (Hamilton)

39. Clupisoma garua (Hamilton)

40. Eutropiichthys murius (Hamilton)

41. Eutropiichthys vacha (Hamilton)

42. Silonia silondia (Hamilton)

Family: SILURIDAE

43. Wallago attu (Bloch)

Family: SISORIDAE

44. Glyptothorax telchitta (Hamilton)

45. Pseudeutropius atherenoides (Bloch)

46. Pseudeutropius gurua (Hamilton)

Order : PERCIFORMES

Family: CENTROPOMIDAE

47. Ambassis nama (Hamilton)

Family: NANDIDAE

48. Nandus nandus (Hamilton)

49. Badis badis (Hamilton)

Family: SCIAENIDAE

50. Pama pama (Hamilton)

Family: GOBIIDAE

51. Glossogobius giuris gluris (Hamilton)

Order : OPHICEPHALIFORMES

Family: CHANNIDAE

52. Channa marulius (Hamilton)

53. Channa punctatus (Bloch)

Order : BELONIFORMES

Family: BELONIDAE

54. Xenentodon cancila (Hamilton)

Order : MASTOCEMBELIFORMES

Family: MASTOCEMBELIDAE

55. Macrognathus aculeatus (Bloch)

56. Mastocembelus armatus (Lacepede)

57. Mastocembelus pancalus (Hamilton)

Order : TETRAODONTIFORMES

Family: TETRAODONTIDAE

58. Tetraodon cuteutia (Hamilton)

HOST - PARASITE LIST

S.N.		
1.	Puntius sarana (Hamilton)	Asymphylodora puntiusi n.sp.
2.	Mystus seenghala (sykes)	Haplorchis attenuatus
3.	Mystus vittatus (Bloch)	Haplorchis piscicola
4.	Rita rita (Hamilton)	Neopodocotyle jhansiensis n.sp.
5		Phylodistomum phulaenci n.sp.
6.	Clupisoma garua (Hamilton)	Neobucephalopsis chauhani n.sp
7.		Haplorchis piscicola
8.	Wallago attu (Bloch)	Haplorchis attenuatus
9.	Gyptothorax telchitta (Hamilton)	Astiotrema reniferum (Looss 1898) Stossich, 1904
10.	Ambasis nama (Hamilton)	Neopodocotyle betwai n.sp.
11.	Channa punctatus (Bloch)	Genarchopsis jaini n.sp.
12.	Xenontodon cancila (Hamilton)	Bucephalopsis bundeli n.sp.
13.		Bucephalopsis ramalingami n.sp.
14.	Macrognathus aculeatus (Bloch)	Caballeroia chauhani n.sp.
15.		
16.		
17.		
18.		

PART - II

TAXONOMY AND MORPHOLOGY OF CERTAIN DIGENETIC TREMATODES

Family : Opecoelidae Ozaki, 1925

Sub Family : Plagioporinae Manter, 1947

Genus : Neopodocotyle Dayal, 1950

Neopodocotyle betwai n.sp.
(Plate I, Figs. 1 - 3)

Numerous specimens were recovered from the intestine of a fresh water fish, Ambasis nama (Hamilton) collected from river Betwa in the district Jhansi. On detailed study these were found new to science. They are named as Neopodocotyle betwai n.sp. after the name of river from where the host was procured.

DESCRIPTION

Body elongated, aspinose with rounded extremities, 3.21 to 4.68 mm, long by 0.86 to 1.32 mm wide between ovary and ventral sucker. Oral sucker spherical, subterminal, 0.35 to 0.45 mm, long by 0.34 to 0.47 mm wide. Ventral sucker spherical, smaller, equal or larger than oral sucker, 0.38 to 0.48 mm, long by 0.30 to 0.50 mm wide at 0.68 to 0.89 mm from anterior extremity. Prepharynx absent; pharynx muscular, oval, 0.15 to 0.26 mm, long by 0.14 to 0.24 mm wide; esophagus tubular, coiled, 0.13 to 0.18 mm, long bifurcating into slender intestinal caeca, extending upto posterior end of body.

Excretory bladder tubular extending to level of posterior testis; excretory pore terminal.

Genital pore slightly to left side of pharynx at 0.54 to 0.76 mm from anterior extremity.

Testes oval or spherical, equal or subequal, diagonal and post equatorial. Anterior testis, 0.32 to 0.45 mm long by 0.28 to 0.46 mm wide at 1.88 to 2.94 mm from anterior extremity. Posterior testis equal, smaller or larger than anterior testis, 0.35 to 0.54 mm long by 0.27 to 0.46 mm wide. Cirrus pouch claviform extending from genital pore to middle of ventral sucker, 0.46 to 0.66 mm long by 0.12 to 0.18 mm wide. Vesicula seminalis tubular, convoluted, occupying posterior part of cirrus pouch, 0.44 to 0.65 mm, long by 0.05 to 0.07 mm wide; pars prostatica globular, 0.13 to 0.18 mm long by 0.04 to 0.06 mm wide; ejaculatory duct tubular, 0.13 to 0.17 mm long; cirrus muscular with striations at its anterior end. Ejaculatory duct and pars prostatica surrounded by large number of prostate gland cells.

Ovary oval or spherical, postacetabular, preequatorial, 0.25 to 0.34 mm long by 0.24 to 0.38 mm wide at 1.04 to 1.38 mm from anterior extremity. Receptaculun seminis pear shaped, posterior to ovary, 0.24 to 0.35 mm long by 0.08 to 0.14 mm wide. Vitellaria follicular extending from middle region of ventral sucker to hind end of body mainly along outer margin

of caeca but extending into intercecal space and back of posterior testis. Uterine coils occupying space between anterior testis and genital pore. Metraterm muscular, lying on left side of ventral sucker. Eggs oval with thick brown shell, 0.074 to 0.092 mm long by 0.053 to 0.060 mm wide.

Host — Ambasis nama (Hamilton)

Location — Intestine

Locality — Betwa river, District Jhansi.

DISCUSSION

Dayal (1950) erected the genus Neopodocotyle for N. indica as its type species in having ventral sucker near oral sucker and in the extension of uterus from anterior end of testes upto ventral sucker under the family Allocreadiidae looss, 1903. Yamaguti (1958) has reduced this genus to the rank of subgenus under Podocotyle (Duj., 1845) and placed it under the sub family Allocreadiinae Looss, 1920 of the family Allocreadiidae. He divided the genus into three subgenera namely Podocotyle, Podocotyloides Yamaguti, 1934 and Neopodocotyle. He distinguished Neopodocotyle from Podocotyle and Podocotyloides in having overy separated from the anterior testis by uterus. Further he distinguished Podocotyloides from Podocotyle in having acetabulum pedunculate, surmounted puckered margin of peduncle and in having excretory vesicle long and reaching beyond ovary. Skrjabin, Petrow and Koval (1958) recognised Podocotyloides as a distinct genus.

Mehra (1966) regarded Podocotyle and Podocotyloides and Neopodocotyle as distinct genera under the sub family Plagioporinae Manter, 1947 of the family Opecoelidae Ozaki, 1925, He maintains Neopodocotyle as a distinct genus as it does not possess acetabulum with short peduncle and the genital pore lies to the left of pharynx whereas in Podocotyle it lies slightly to the left of intestinal bifurcation or at level of oesophagus. He also recognises Podocotyloides as a distinct genus as it has much longer excretory vesicle which extends almost to acetabulum, beyond the anterior limit of vitellaria in having comma shaped metraterm provided with manchette and in the extension of cirrus sac a little farther than the posterior limit of the anterior third of the body and in having eggs with a knob like protuberance at the antiopercular pole. The author is in agreement with Mehra in considering the genera Podocotyloides and Neopodocotyle distinct from the genus Podocotyle as the characters suggested by him for separating the various genera are based on valid grounds. The genus Neopodocotyle is distinct from Podocotyle as the position of genital pore lies to left side of pharynx, the pars prostatica is distinct and uterus extending to anterior testis are the distinctive features.

Due to the position of genital pore on the left side of phyrynx and the uterus extending to anterior testis, the present form is referred to the genus Neopodocotyle Dayal,1950.

The new form differs from N. indica in the extension of cirrus pouch up to middle of ventral sucker, in having a convoluted vesicula seminalis, in the possession of a distinct pars prostatica and in having striations at the anterior end of the cirrus.

The new form differs from another new species of the genus, Neopodocotyle jhansiensis (described in this thesis) in following characters (i) N. jhansiensis has the two testes very close to one another, and its cirrus sac extends over the antero-lateral aspect of the right side of ventral sucker and sometimes reaches anteriorly, crosses the left intestinal caeca.

Accordingly it is regarded as new with the specific name N. betwai n.sp.

KEY TO THE SPECIES OF THE GENUS NEOPODOCOTYLE DAYAL,1950

1. Cirrus pouch extends upto middle part of the ventral sucker and pars prostatica present N. betwai n.sp.

Cirrus pouch extending upto hind end of the ventral sucker and pars prostatica absent - N. indica Dayal 1950

Cirrus pouch (sac) extends anteriorly, crosses the anterior part of right intestinal caeca - N. jhnsiensis.

Family : Opecoelidae Ozaki, 1925

Sub family : Plazioporinae Manter, 1947

Genus : Neopodocotyle Dayal, 1950

Neopodocotyle jhansiensis n.sp.

(Plate II, Fig. 1)

Five specimens of a trematode were collected from the intestine of the siluroid fish, Rita rita (Hamilton), obtained from the river Betwa in District Jhansi. Only two of the three fishes examined were found infected with these trematodes. On examination, the specimens were found to be a new species of the genus Neopodocotyle Dayal, 1950.

The description given below is based on the study of stained, permanent whole mounts of three specimens. All measurements are given in millimetres.

DESCRIPTION

The worms are small and elongated with rounded anterior and posterior ends. The body is aspinose and measure 4.30 - 4.76 in length and 1.12 - 1.44 in maximum breadth, which is in the region of ovary.

The oral sucker is circular, subterminal and 0.32 - 0.36 x 0.39 - 0.45 in size. The ventral sucker, 0.38 - 0.47 x

0.47 - 0.50 is slightly larger than the oral sucker and situated at a distance of 0.9 - 1.12 from the anterior end of the body. The average ratio between the oral and the ventral sucker is 1 : 1.28.

The mouth is situated in the anterior part of the oral sucker. It is followed by a prominent muscular pharynx, lying contiguous with the oral sucker and measuring 0.19 - 0.21 x 0.23 - 0.25. The pharynx leads into a narrow oesophagus, 0.25 long. The intestinal caeca extend almost up to the hind end of the body and are not clearly visible due to overlapping of the vitelline follicles.

The excretory pore lies at the posterior end of the body. It leads into a long tubular excretory bladder, which extends beyond the anterior testis.

The genital pore is very prominent and is surrounded by a circlet of spines. It lies on the leftside of the oesophagus immediately in front of the point of origin of the intestinal caeca.

The testes are roughly oval and tandem. They lie 0.21 - 0.28 apart, in the posterior half of the body. The anterior testis measures 0.43 - 0.50 x 0.47 and lies 2.4 - 2.6 mm. behind the anterior end of the body. The posterior testis is slightly larger than the anterior and measures 0.54 - 0.60 x 0.47 - 0.54.

The cirrus sac has a transparent membranous wall and is dorsal to and on the right side of the ventral sucker. It is 0.5 - 0.6 long by 0.47 - 0.54 broad. It extends anteriorly from the level of the posterior margin of the ventral sucker and then runs obliquely to cross the left intestinal caecum to open at the genital pore. Sometimes the cirrus sac extends over the antero-lateral aspect of the right side of the ventral sucker (see Figure). A distinct pars prostatica appears to be absent. The broader posterior half of the cirrus sac is occupied by a coiled vesicula seminalis and this is followed by a long ejaculatory duct. The prostate gland cells surround the ejaculatory duct and the anterior lobes vesicula seminalis.

The ovary is roughly spherical and is 0.32 - 0.36 x 0.31 - 0.32 in size. It lies at a distance of 1.41 - 1.65 (about 1/3 of the body length) from the anterior end of the body. A large sac-like receptaculum seminis, measuring 0.31 - 0.45 x 0.13 - 0.18, extends behind the ovary and is seen to occur either on the right or left side of the median line.

The viteline glands consist of large follicles extending from the level of the middle region of the ventral sucker to the posterior end of the body. The follicles are mainly circumcaecal but extend into the intercaecal space

between the two testes and become confluent in the region behind the posterior testis.

The uterus occupies the space between the anterior testis and the ventral sucker. The terminal part of the uterus runs along the outer border of the cirrus sac.

The eggs are oval, measuring 0.073 - 0.085 x 0.036 - 0.48, and are provided with a thin yellowish - brown shell.

Host — Rita rita (Hamilton)

Location — Intestine

Locality — Betwa river, District Jhansi.

DISCUSSION

The genus Neopodocotyle was created by Dayal (1950) for the reception of the trematode Neopodocotyle indica collected from the intestine of Caillichrous bimaculatus at Lucknow. Yamaguti (1958) has regarded Neopodocotyle as a subgenus of the genus Podocotyle, which has been suitably revised by Park (1937), and has provided a key to the identification of its three subgenera namely, Podocotyle, Podocotyloids and Neopodocotyle. Podocotyle and Podocotyloids are marked out by having the uterus extending between the ovary and the ventral sucker. Podocotyloids is further characterized

by the possession of a pedunculated acetabulum surmounted by the puckered margin of the peduncle and a long excretory vesicle reaching beyond ovary. In Neopodocotyle, the uterus extends between the anterior testis and acetabulum.

The geographical distribution of the above forms is also peculiar. Species of Podocotyle have been reported mostly from marine fishes from Canada, Florida, California, Japan, the English Channel, White sea, Galapagos islands etc. Podocotyloids petallophallus (the only species hitherto known) has been reported by Yamaguti (1934) from Japan. Neopodocotyle, with its single species N. indica so far recorded is known from India only. The third species of this genus is reported and described in this thesis as N. betwai. It is difficult to comprehend why the three subgenera of a cosmopolitan form like Podocotyle should have such strictly limited distribution. Many forms of the subfamily Allocreadiinae, for example, Plagioporus and Podocotyle, show minor differences in characters, but they have been assigned distinct generic status. On these grounds, it seems reasonable to regard Neopodocotyle as a valid genus until further investigations and experimental evidence prove to the contrary.

The new form differs from N. betwai n.sp. in having two testes apart, at a distance from one another. In N. betwai two testes are very close to one another.

The new form described here differs from Neopodocotyle indica in the following respects :

1. The ventral sucker is larger than the oral sucker and is situated at about 20% of the body length from the anterior end. The average ratio between the oral and ventral sucker is 1 : 1.28. In N. indica, the ventral sucker is nearly equal to the oral sucker and it lies at about 15% of the body length from the anterior end. The ratio between the oral and ventral sucker is 1 : 1.01.

2. Testes have a relatively more posterior position. The anterior testis lies at about 60% of the body length from the anterior end. In N. indica, the anterior testis is immediately post-equatorial and the posterior testis is relatively farther from the posterior end than in the form under discussion.

3. The genital pore is surrounded by a circlet of spines.

4. The metraterm and the cirrus sac are both on the same (right) side of the ventral sucker. In N. indica, the the metraterm is on the left and the cirrus sac on the right side of the ventral sucker.

Therefore, the form described here is regarded as new and it is proposed to name it as Neopodocotyle jhansiensis.

Family : Monorchiidae Odhner, 1911

Sub family : Proctotrematinae Odhner, 1911, emend. Yamaguti, 1934

Genus : Asymphylodora Looss, 1899

Asymphylodora puntiusi n.sp.

(Plate III, Fig. 1)

During the course of examination of a collection of digenetic trematodes of fresh water fishes of Bundelkhand region, one new species of the genus Asymphylodora was collected from the intestine of Puntius sarana. It is named after the generic name of the host. It is described here. All measurements are in millimeters.

DESCRIPTION

The worms are very small with an elongated and flattened body, 0.79 - 1.28 long and 0.28 - 0.49 in maximum breadth between acetabulum and ovary (average length/breadth ratio = 2.5/1). The integument of the anterior end is beset with a few rows of very minute spines. A row of very minute spines is also present on the oral sucker. Deeply staining unicellular gland are present in the anterior region of the body. The details of measurements taken from the type specimen, 1.12 long and 0.48 in maximum breadth, are given below :

Oral sucker subterminal, measures 0.14 x 0.16, and leads directly into a well developed muscular pharynx, 0.09 x 0.016. Oesophagus 0.12 long and bifurcating into two simple intestinal caeca extending posteriorly upto the level of middle of the testis (i.e. upto 80% of the body length from the anterior end). Acetabulum measures 0.16 x 0.18, lies 0.27 from anterior end (i.e. near 25% of body length from the anterior end), and covers the point of intestinal bifurcation. Excretory bladder tubular. Excretory pore terminal at the posterior end.

Testis single, oval, massive, post-ovarian, measures 0.31 x 0.16, and lies near the posterior end of body. Cirrus sac prominent and retort-shaped, 0.28 x 0.10, broadest at its posterior end, situated obliquely on the left side of acetabulum and extending posteriorly much beyond it and crossing the left caecum anteriorly. Vesicula seminalis voluminous, non-bipartite and occupying almost the whole of the cirrus. Pars prostatica and ductus ejaculatorious very short. Cirrus 0.105 long, well developed, curved and unarmed. Genital pore sub-marginal, extracaecal and at the level of middle of acetabulum between left intestinal caecum and body wall.

Ovary 0.10 x 0.15, median, post-equatorial, immediately pretesticular and in contact with the anterior border of the

testis. Mehlis' gland complex anterolateral to ovary. Receptaculum seminis present. Vitellaria lateral, mostly extracaecal and composed of few follicular acini extending from the level of middle to posterior border of acetabulum to the caecal ends (about middle of testis). Uterus occupies the entrire space between acctabulum and the gonads and extend into the post-testicular zone upto the posterior end of the body. Metraterm runs parallel to the cirrus sac and opens into genital atrium. Eggs measure 0.0198 x 0.009 and each one contains a developing embryo.

Host : Puntius sarana (Hamilton)

Location : Intestine

Locality : Betwa river, District Jhansi.

DISCUSSION

Yamaguti (1958) has listed sixteen species of the genus Asymphylodora. Of these, a number of species have been regarded as synonymous by Witenberg and Eckmann (1934). So far as the authors are aware, only three species of Asymphylodora namely, A. indica H.D. Srivastava, 1936, A. kedarai N.N. Srivastava, 1961 and A. ritai Gupta and Agrawal, 1967 have been reported from India. Rai (1971) collected and studied a number of specimens of Asymphylodora tincae (Modeer, 1790) from Puntius sarana, Puntius sophore

and Mystus vittatus at Gorakhpur (U.P). He found that specimens of A. tincae showed a wide range of variations in the disposition of organs and A. tincae, A. kedarai and A. ritai came within the range of those variations. Rai, therefore, conduded that A. indica, A. kedarai and A. ritai were identical to A, tincae the type species of the genus Asymphylodora. It is difficult to agree with Rai (1971) if a comparison is made of his description of A. tincae with those of A. indica, A. kedarai and A. ritai.

Asymphylodora tincae Rai, 1971 - Oral sucker larger than acetabulum; prepharynx present; intestinal caeca upto ovary or anterior level of testis; cirrus unarmed; seminal vesicle bipartite; vitellaria from middle of acetabulum to ovarian zone; eggs with a spine-like process at the non-operculate end, excretory bladder tubular.

Asymphylodora indica Srivastava, 1936 - Large size ; oral sucker larger than acetabulum; long oesophagus; more anterior extent of vitellaria; cirrus sac does not extend beyond acetabulum; eggs unfilmented and without spine; Y-shaped bladder.

Asymphylodora kedarai Srivastava, 1951 - Oral sucker smaller than acetabulum; cirrus and metraterm unarmed; no prepharynx; very short oesophagus; cirrus sac extends beyond

acetabulum; non operculate and non spiny eggs; caeca up to middle of ovary; seminal vesicle bipartite; vitellaria from middle of acetabulum to caecal ends; excretory bladder tubular.

A. ritai Gupta and Agrawal, 1967 - Oral sucker larger than acetabulum; excretory bladder tubular.

It would appear that Rai's specimens are comparable with A. ritai because of the possession of an oral sucker larger than acetabulum and a tubular excretory bladder. Rai's suggestion that A. indica, A. kedarai and A. ritai are identical to A. tincae does not seem to be tenable.

The new form described here resumbles A. kedarai in the possession of an unarmed cirrus and metraterm, an oral sucker smaller than acetabulum, over lapping of bifurca by acetabulum and in the position of the genital pore. But the following differences between the new form and A. kedarai cannot be ignored.

	A.kedarai	A. puntiusi n.sp.
Length/Breadth ratio	1.7/1	2.5/1
Posterior extent of intestinal caeca	up to middle of ovary	up to middle of testis
Ovary	at the junction of 3rd and 4th quarters of body	at 60% of body length from the anterior end

Vitellaria	up to ovarian zone	up to middle of testis.
Seminal Vesicle	bipartite	not bipartite

On account of these differences, the form described here is considered to be a new species and is named Asymphylodora puntiusi after the generic name of the host.

Family : Gorgoderidae Looss, 1901

Sub family : Gorgoderinae Looss 1899

Genus : Phyllodistomum Braun, 1899

Phyllodistomum hardayali n.sp.

(Plate III, Fig. 2)

Seven specimens of this digenetic trematode were found from the urinary bladder of a fresh water fish, Gudusia chapra (Hamilton) collected from the river Ken in the District Banda during October, 1995. It is a new species and is named P. hardayali in honour of an eminent helminthologist late Dr. Hardayal Srivastava (Indian Veterinary Research Institute, Izatnagar). All measurements are given in mm.

DESCRIPTION

Body flattened, aspinose and with an anterior narrow portion and a posterior expanded portion. Body length 2.05 and maximum breadth 0.8 in the region of ovary. Narrow anterior part of body measures 1.05 x 0.44, while the posterior expanded part is 1.00 x 0.80. Oral sucker terminal and circular, 0.25 x 0.25, and larger than acetabulum (0.22 x 0.22) lying in the posterior region of the narrow anterior part of body 0.82 from the anterior end. Mouth near the anterior end of oral sucker. Pharynx absent. Oesophagus small, looped

and bifurcating into two simple unbranched intestinal caeca reaching up to some distance short of the posterior end of body. Excretory bladder tubular. Excretory pore near posterior end of body.

Testes two, obliquely placed in the middle region of expanded part of body and irregular in shape. Anterior testis 0.092 x 0.072 and 1.37 from anterior end. Posterior testis larger, 0.13 x 0.09, deeply lebed. Cirrus sac absent. Vesicula seminalis postbifurcal and bipartite. Genital pore immediately post-bifurcal.

Ovary 0.164 x 0.136, with large lobes, postacetabular immediately anterior to posterior testis and 1.2 from anterior to posterior testis and 1.2 from anterior end of body. Receptaculum seminis absent. Vitellaria as two compact structures between ovary and acetabulum. Uterus mostly occupies the posterior half of the expanded part of body and extends into extracaecal fields. Anteriorly the uterus runs dorsal to the acetabulum to open at the genital pore. Eggs large, oval 0.056 x 0.024 in size, and embryonated.

Host : Gudusia Chapra (Hamilton)

Location : Urinary bladder

Locality : Ken river, District Banda.

DISCUSSION

A total of 15 species (13 from fishes and 2 from amphibians) of the genus Phyllodistomum have been reported from India. Rai (1971) has critically reviewed the Indian species of this genus and has shown that its various species can be divided into three distinct groups on the basis of the relative size of oral and ventral suckers. He has given sufficient reasons for the suppression of a number of species on grounds of synonymity. The form under reference has an acetabulum smaller than the oral sucker, a condition that occurs in P. vachius Dayal, 1949, P. vittatusi Gupta, 1953 and P. chauhani Motwani and Srivastava, 1961 amongst the reported Indian species of the genus Phyllodistomum. A comparison of the new form with P. vachius, P. vittatusi and P. chauhani is presented in Table I from a perusal of which it would appear that P. vachius, P. vittatusi and P. chauhani are identical. This point of view is in complete agreement with that of Rai (1971) who arrived at the same conclusion after a critical study of various species of Phyllodistomum from fishes. The new form differs from P. vachius, P. vittatusi on account of possessing the following combination of distinguishing characters :

1. The narrow anterior partof the body is half of the total body length, which is more than twice the maximum breadth.

2. The testes do not have entire margins. The anterior testis is smaller than the posterior one and relatively more posterior in position and situated at the junction of middle and posterior third of body.

3. Acetabulum is but slightly smaller than the oral sucker and it is relatively more posterior (at 40% of body length from anterior end) in position.

4. Ovary is just behind the vitelline gland on one side (not by its side).

5. Vesicula seminalis is bipartite.

These characters justify the creation of a new species for the reception of the new form, which is named Phyllodistomum hardayali on account of having relatively longer anterior part in relation to the total length of the body. The occurrence of Phyllodistomum in Gudusia chapra constitutes a new host record.

TABLE I - COMPARISON OF Phyllodistomum hardayali n.sp. WITH P. vachius, P. vittatusi and P. chauhani.

	P.vachius Dayal 1949	P.vittatusi Gupta 1953	P.chauhani Motwani & Srivastava 1961	P.hardayali n.sp.
ost	Eutropiichthys vacha, Mystus aor, Mystus seenghala	Macrones vittatus	Mystus aor, Mystus seenghala	Gudusia chapra
ength/breadth	1.42	1.42	1.38	2.50
arraw anterior art as % of body ength	34 %	38.4%	30.4%	51 %
ral sucker/ ccetabulum	1.34	1.47	1.3	1.1
osition of aceta- ulum at % of body engths from anterior nd	34 %	38.4%	33 %*	40 %
osition of anterior estis at % of body engths from anterior nd	55 %	53%	45 %*	66 %
ize of ovary	Larger than right testis	Larger than testes		Larger than testes
osition of ovary	Left of vite- lline gland	Left of vitellite gland	By the side vitelline gland	Behind the vitelline gland
vary from nterior end	47 %	49 %	46.6%*	60 %
esicula seminalis	Not bipartite 0.035-0.038 x 0.027-0.29	No bipartite 0.021-0.031 x 0.018-0.029	Not bipartite 0.12** in diameter (round?)	bipartite 0.056 x 0.024

* Calculated from figure
** Doubtful observation by Motwani and Srivastava (1961)

Family : Gorgoderidae Looss, 1901

Sub family : Gorgoderinae Looss, 1899

Genus : Phylodistomum Braun, 1899

Phylodistomum phulaenei n.sp.

(Plate IV, Fig. 1)

Only two worms of this species were collected from the urinary bladder of Rita rita (Hamilton) procured from the Betwa river in district Jhansi. On detailed study these were found new to science hence are designated as a new species. The species is named P. phulenei n.sp. and is described as under.

DESCRIPTION

Body spatulate, 4.23 mm long and 2.23 mm wide just behind testicular region of body; anterior part narrow and elongated. 1.8 mm long by 1.10 mm wide and posterior part expanded and nearly circular. 2.52 mm long by 2.23 mm wide. Oral sucker globular, terminal, 0.5 mm in diameter. Pharynx absent; esophagus tubular, 0.19 x 0.08 mm in size. It bifurcates into two intestinal caecae. sinuous extending backwards marginally to terminate 0.25 mm from hind end. Ventral sucker circular, equal to oral sucker, 0.5 mm in diameter located 1.35 mm or nearly 1/3rd of body length from anterior extremity.

Excretory pore dorsal; bladder long, tubular, extending as far as testes. Genital pore median situated between intestinal bifurcation and ventral sucker at a distance of 0.95 mm from anterior extremity.

Testes lobed, intercaecal, subequal, postequatorial, symmetrical in broadest part of hind body and separated by uterine coils; situated at a distance of 2.75 mm from anterior end and 0.28 mm behind ovary; right testis larger than left and 0.53 x 0.40 mm in size, left testis 0.44 x 0.42 mm in size. Cirrus sac absent. Vesicula seminalis free in parenchyma between intestinal bifurcation and ventral sucker, sac like and measures 0.15 x 0.08 mm in size.

Ovary lobed, pretesticular, 0.42 x 0.30 mm in size and situated on left side of vitelline gland at a distance of 0.2 mm from posterior margin of ventral sucker. From its right side arises oviduct leading to ootype. Vitelline glands consist of two divided follicles lying behind ventral sucker one on either side of ootype at a distance of 1.95 mm from anterior extremity; right vitelline gland 0.10 x 0.028 mm and left 0.1 x 0.029 mm in size. Duets from two glands open separately at ootype. A larg number of unicellular glands surround ootype. Uterus arises from hind end of ootype and runs backwards forming coils filling up nearly all space of body posterior to vitelline glands both intra and extra cecally also extending dorsal to ventral sucker to open at genital pore. Eggs oval non operculated 0.0391 - 0.0522 x 0.0194 -

DISCUSSION

The new form belongs to the genus Phyllodistomum Braun, 1899. The following species of the genus Phyllodistomum have been described so far from fresh water fishes of India viz. P. lewisi Srivastava, 1958, P. vachius Dayal, 1949; P.loossi Kaw, 1950; P. singhiai Gupta 1951; P. vittatusi Gupta 1954 P. parorchim Jaiswal, 1957. P. indianum Jaiswal, 1957, P. chauhani Motwani & Srivastava, 1971; P. tripathi Motwani & Srivastava, 1961 and P. srivastavi Rai, 1964. The new form is distinct from all the above species of Phyllodistomum with the exception of P. loossi in having suckers of equal size. The new form differs from P. loossi in having posterior part disc like separated from much narrower anterior portion, in having symmetrical testes and in having ovary anterior to testes.

Therefore, it is regarded a new species with the specific name P. phulenei n.sp. in honour of Dr. Phulene Rai Retd. Professor, Veterinary College, Mathura and an eminent helminthologist.

Host : Rita rita (Hamilton)

Location : Urinary bladder

Locality : Betwa river, District Jhansi.

Family : Gorgoderidae Looss, 1901

Sab family : Gorgoderinae Looss, 1899

Genus : Phylodistomum Braun, 1899

Phylodistomum tripathi

Motwani & Srivastava, 1961

(Plate V, Figs. 1-4)

A large number of specimens of this form were recovered from the intestine of a fresh water fish, Barilius barita (Hamilton) and five immature specimens from the intestine of Pseudeutropius garua (Ham.). Both fishes were collected from Betwa river in the District Jhansi. As this species has not hitherto been described adequately, it is therefore redescribed.

DESCRIPTION

Body dorsoventrally flattened, spatulate, 1.55 - 4.58 mm long and 0.74 - 2.02 mm wide at its broadest point in hind body. Forebody cylindrical, narrow, 0.90 - 2.7 x 0.53 - 0.80 mm in size and posterior portion broad and foliate. 0.69 - 2.0 x 0.74 - 2.02 mm in size. Three pairs of feebly developed semicircular puckerings present on lateral sides of hind body. Posterior end of body with well defined notch. Oral sucker terminal, oval, 0.19 - 0.50 x 0.19 - 0.45 mm in size. Esophagus long, narrow, straight or curved, 0.11 - 0.45 mm in length, bifurcates into two

intestinal caeca that terminate at 0.17 - 0.50 mm from hind end of body. Caeca broad with crinkled margins, and in some immature specimens very close together or apart from each other. Ventral sucker spherical larger than oral sucker. 0.3 - 0.6 mm in diameter in anterior third of body at 0.67 - 2.0 mm from anterior extremity.

Excretory pore dorsally at posterior end of body. Excretory bladder tubular extending upto hind margin of ventral sucker then dividing into right and left branches. Genital pore median, between intestinal bifureation and ventral sucker at 0.43 - 1.40 mm or nearly 1/4th from anterior extremity.

Testes deeply lobed, subequal, intercaecal, postequatorial, either close to posterior extremity or quite anterior to it, diagonal or symmetrical in broadest part of hind body well separated by uterine coils. Right testis at level of ovary but not in close proximity, 0.20 - 0.48 x 0.20 - 0.60 mm in size at 0.30 - 1.12 mm from hind end. Left testis slightly larger than right located near termination of caeca or slightly anterior to it, 0.25 - 0.55 x 0.20 - 0.50 mm in size at 0.15 - 0.90 mm from hind end. Cirrus sac absent. Vesicula seminalis saccular 0.08 - 0.25 x 0.03 - 0.13 mm in size.

Ovary submedian, pretesticular and consists of 4.5 lobes, situated just behind left vitelline gland, 0.10 - 0.25

x 0.09 - 0.25 mm in size at 1.06 - 2.8 mm from anterior extremity. Vitelline glands two, bilobed masses lying asymmetrically on both sides of body just behind ventral sucker close in front of ovary; right vitelline gland measures 0.03 - 0.12 x 0.11 - 0.31 mm in size and left vitelline gland, 0.03 - 0.10 x 0.11 - 0.32 mm in size. Two vitelline ducts run transversely and unit to form a common yolk reservoir from where a median vitelline duct originates and joins Mehlis' gland. Uterus arises anteriorly from ootype, then bends ventrally and subsequently filling posteriorly hind body inter and extracaecally. Anteriorly it runs dorsal to ventral sucker to open at genital pore. Eggs oval, non operculated, 0.0512 - 0.0752 x 0.0259 - 0.0492 mm in size.

The present specimen in my collection forms the first host and locality record from this region.

Host : Barilius barila (Hamilton)

Location : Intestine

Locality : River Betwa, District Jhansi (U.P)

DISCUSSION

The present form belongs to Phyllodistomum sp. Bhalerao, 1937 and P. tripathi Motwani & Srivastava, 1961 but however differs from both of them, in the shape and position of testes and ovary in having a well defined posterior notch and in the bilobed nature of vetellaria. These differences are considered variations within the species.

Family : Gorgoderidae Looss, 1901

Sub family : Gorgoderinae Looss, 1899

Genus : Gorgotrema Dayal, 1938

Gorgotrema barbius Dayal, 1938

(Plate VI, Fig. 1-3)

Only seven trematodes of this species were recovered from the kidneys of a fresh water fish, Barilius bola (Hamilton) collected from the river Ken in District Banda during November, 1994. They beong to family Gorgoderidae Looss, 1901 and the sub family Gorgoderinae Looss, 1899. On their detailed study they are identified as belonging to species G. barbius Dayal, 1938. The worms are redescribed here furnishing all the details.

DESCRIPTION

The present form Gorgotrema barbius is a dorsoventrally flattened trematode of white colour. The cuticle is covered with small scattered spines. The anterior portion of the body is narrow and elongated, while the posterior portion of the body is much expanded and nearly circular. The worm is 4.4 mm long by 2.95 mm broad. The narrow anterior part is 1.87 mm long by 0.96 mm broad in the region of the genital

opening and the posterior expanded portion is 2.53 mm long by 2.95 mm broad.

The oral sucker is oval and subterminal. It is 0.47 mm long by 0.44 mm wide. The ventral sucker is larger than the oral sucker and oval in shape. It is 0.45 mm long by 0.47 mm wide. It is situated at the junction of the neck-like projection and the broad portion of the body, at a distance of 1.57 mm from the anterior end.

The mouth is a slit-like opening on the ventral side of the oral sucker and opens into a funnel-shaped buccal eavity. The latter leads into a long oesophagus 1.03 mm long by 0.05 mm broad. The oesophagus bifurcates into two simple and broad intestinal eaeca which terminate at a distance of 0.6 mm from the posterior end of the body.

The excretory pore is situated on the ventral side near the posterior end of the body. It leads into a long tubular bladder extending as far as the posterior follicles of the testes. A number of excretory tubules open on either side of the excretory bladder throughout its entire length.

The female organs consist of an ovary and its duct together with a number of accessory organs associated with it. The ovary is situated on the right side of the right vetlline gland, and is partly internal to and partly overlaps the right

intestinal caecum on the ventral side. It is oval in shape and lies at distance of 2.15 mm from the anterior end. It is 0.19 mm long by 0.14 mm broad. From its left side arises the oviduct which opens into the ootype. The vitelline glands consist of two large undivided follicles. They are situated in the middle of the body, on either side of the ootype, behind the ventral sucker. The right vitelline gland is 0.2 mm long by 0.12 mm broad and is situated at a distance of 2.1 mm from the anterior end. The left vitelline gland is irregular in outline and is 0.18 mm long by 0.17 mm broad. It is situated at a distance of 2.16 mm from the anterior end. The ducts from the two glands open separately at the ootype. A large number of unicellular shell-glands, each with a large nucleus, surround the ootype.

The genital opening is situated between the oral sucker and the intestinal bifurcation, at a distance of 1.18 mm from the anterior end and 0.3 mm in front of the intestinal bifurcation. It leads into a common genital atrium into which open both the male and the female genital ducts.

The male reproductive organs consist of a large number of small rounded or oval testes. They are scattered irregularly in the anterior half of the broad portion of the body, behind the ovary and between the intestinal caeca. The number of testes is between 34 and 40. In the type specimen the number is 38.

The cirrus sac is absent. The vesicula seminalis lies freely in the parenchyma and is oval in shape. It is 0.075 mm long by 0.06 mm wide and opens into a short ejaculatory duct 0.03 mm long. The latter opens into the genital atrium on the left side of the opening of the female duct.

The uterus arises from the posterior side of the ootype between the openings of the vitelline ducts. It runs backwards forming coils mainly between the intestinal caeca, but also extends over the latter on the ventral side. Anteriorly it runs dorsal to the ventral sucker to open at the genital atrium on the right side of the opening of the male duct.

The eggs are oval in shape with a thin light-brown shell. They measure 0.031 - 0.035 mm by 0.022 - 0.24 mm.

The distinguishing characters of this species may be summarised as follows :

1. Body flat, divided into an anterior elongated neck like portion and a posterior broad circular portion.

2. Cuticle covered with small sattered spines.

3. A funnel-shaped buccal cavity present. Oesophagus long, intestinal caeca simple and broad.

4. Excretory bladder tubular with lateral branches.

5. Genital opening anterior to intestinal bifurcation.

6. A common genital atrium both for male and female ducts present.

7. Testes follicular, in large numbers (34 - 40), scattered in the anterior half of the broad portion of the body.

8. Uterine coils posterior to ootype, most intercaecal.

Host : Baralius bola (Hamilton)

Location : Kidney

Locality : Ken river, District Banda (U.P)

DISCUSSION

The Present specimens belongs to the family Gorgoderidae and the sub family Gorgoderinae, as clearly appears from the description given above. It differs from all the known genera of the sub family (Gorgodera, Phyllodistomum, Macia and Xystretum) in the possession of funnel-shaped buccal cavity, in the position of the genital pore, in the shape of the excretory bladder, in the number and configuration of the testes. Gorgodera is the only genus in which the number of testes is more than two, but in Gorgodera the testes are nine in number and are arranged in two longitudinal rows one behind the other, one row consisting of four and the other of five testes. In Gorgotrema the testes are in large numbers (34-40) scattered irregularly in the anterior half of the broad portion of the body. The difference in the number and the configura-

tion of the tests, the position of the genital pore, and the possession of the buccal-funnel is enough to identify them as belonging to Gorgotrema barlius Dayal, 1938.

Family : Bucephalidae Poche, 1907

Sub family : Bucephalinae Nicoll, 1914

Genus : Bucephalus Baer, 1827

Bucephalus bundelkhandi n.sp.

(Plate VII, Figs 1-2)

Three specimens of a gasterostome trematode were collected from the small intestine of a fresh water fish, Corica soborna (Hamilton) netted at Jhansi from Betwa river. A detailed examination of the material revealed that it represented a new species of the genus Bucephalus Baer 1827. The description given below is based on the study of the stained, permanent whole mount of one of the three specimens which showed little variation. All measurements are given in millimetres.

DESCRIPTION

Body spinose in the anterior half, elongated, 1.74 long and 0.29 in maximum breadth in the region of ovary and intestinal sac. Rhynchus sucker like, 0.12 x 0.12, with four rentacles, each carrying near its distal end an inwardly directed blunt process. Mouth opening at the junction of middle and posterior third of body, 1.16 from the anterior end; pharynx globose, 0.08 x 0.08 and muscular; intestine sac like and medial to ovary.

Excretory pore at posterior end of the body, excretory bladder sac-like and extending anteriorly upto a level between the vitellaria and rhynchus.

Tesets two, obliquely placed in the middle of the posterior half of body; anterior testis 0.12 x 0.14 with an anterior concavity accommodating the pharynx; posterior testis 0.14 x 0.12, postero-medial to anterior testis. Cirrus sac large and tubular, 0.26 x 0.08 extending anteriorly upto the middle of posterior testis and containing an oval seminal vesicle, a pars prostatica with diffuse prostate glands and a short ductus ejaculatorius; genital tongue prominent; genital pore sub terminal and ventral.

Ovary entire, pretesticular, oval, 0.12 x 0.05, almost marginal in the middle third of body. Uterus extends anteriorly upto a level between the rhynchus and vitellaria, which consist of 12-13 follicles on each side in the pre-ovarian region of body; metraterm runs medial to the cirrus sac and opens into the genital sinus; eggs not observed.

Host : Corica soborna (Hamilton)
Location : Small intestine
Locality : Betwa river, Jhansi (u.P.)

DISCUSSION

In the genus Bucephalus (Bucephalidae, Gasterostomata, Trematoda), the tentacles associated with the rhynchus show

specific differences in shape and number (Chauhan 1954). A key to the species of the genus Bucephalus has been given by Srivastava (1938), Chauhan (1954) and Kakaji (1969). In all, ten species of this genus have been described from India . These are B. aoria Verma, 1936; B. tridenticularia Verma, 1936; B. jagannathai Verma, 1936; B. indicus Srivastava, 1938; B. gangeticus Srivastava, 1938; B. barina Srivastava, 1938; B. tritentacularis Srivastava, 1963; B. allhabadensis Srivastava, 1963; B. bagarius Srivastava 1963 and B. octotentacularis Kakaji, 1969. Of these ten species, only B. gangetious Srivastava 1938 is known to have four tentacles, which are studded with minute pointed spines and are devoid of any processes. Again, in B. gangeticus the gonads are situated close together to the right of the median line and the cirrus sac extends anteriorly up to the anterior level of the anterior testis. None of the species described upto date possess a combination of characters shown by the specimens obtained from Corica saborna . There are four tentacles, but each has an inwardly directed process. The new form described here has an entirely different disposition of testes and structure of the tentacles. Therefore, the author regards the present form to be a new species to which the name Bucephalus bundelkhandi is given which is related to Bundelkhand region.

Srivastava (1963) considered B. tridenticularia Verma, 1936 to be a synonym of B. indicus Srivastava, 1938, but

Kakaji (1969) has revalidated the two species. Srivastava (1938) did not include B. aoria Verma, 1936 in his key as he doubted the validity of this species. However, Yamaguti (1958) has considered B. aoria to be a valid species. With the description of the present form, the genus Bucephalus now includes 11 species, for the identification of which a key is given below :

KEY TO THE INDIAN SPECIES OF BUCEPHALUS

1.	Tentacles 3 in number	B. tritentacularis Srivastava, 1963
2.	Tentacles 4 in number, each tentacle simple, unbranched and studied with spines	B. gangeticus Srivastava, 1938
	Each tentacle with an inwardly directed process	B. bundelkhandi n.sp.
3.	Tentacles 5 in number. Each tentacle with numerous rose-thorn shaped hooks at the base	B. barina Srivastava, 1938
	Each tentacle devoid of hooks but with an apical know	B. allahabadensis Srivastava, 1963
4.	Tentacles 6 in number. Each tentacle with two lateral processes; cirrus sac extends upto anterior margin of posterior testis.	B. indicus Srivastava, 1938
	Each tentacle with a single short lateral process; cirrus extends upto anterior margin of anterior testis	B. jagannathai Verma, 1926
5.	Tentacles 7 in number	B. bagarius Srivastava, 1963
6.	Tentacles 8 in number. Tentacle apex like arrow head; cirrus sac extends up to pharynx	B. tridenticularia Verma, 1936

	Tentacle simple and without any process; cirrus sac extends up to hind end of ovary	B. octotentacularis Kakaji, 1969
7.	Tentacles as 14 - 22 short processes or fimbriae; testes on two sides of body and separated by pharynx	B. aoria Verma, 1936

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Family : Bucephalidae Poche, 1907

Sub family : Bucephalinae Nicoll, 1914

Genus : Bucephalopsis (Diesing, 1855) Nicoll, 1914

Bucephalopsis bundeli n.sp.

(Plate VIII, Fig. 1)

Twenty two specimens of Xenontodon cancila (Hamilton), collected from Ken river in District Banda, were examined for trematode parasites. Six of them harboured twenty seven gasterostomes. These were fixed in 10% formalin for twenty hours and then were transferred to 5% formalin. The worms were stained in Gower's acidified carmine. Drawings were made with help of camera lucida. The host specimens were netted from River Ken, District Banda, U.P.

Srivastava and Chauhan (1972) reviewed the Indian gasterostomes and restricted the genus Bucephalopsis for the cerearia Bucephalopsis haimeanus and transferred all the adult species to the genus Prosorhynchoides Dollfus, 1929. In the present study the genus Bucephalopsis has been considered in the composite sense. All measurements are in millimeters.

DESCRIPTION

Body broad rounded anteriorly, narrow posteriorly, a constriction at the level of posterior border of anterior sucker distinctly marks the sucker area; worm measures 1.139 x

0.527 mm; cuticle covered with minute spines, 0.004 mm, anterior sucker discoid, strongly muscular, 0.258 x 0.211; Pharynx 0.0684 in diameter, post-equatorial at two third line of the body; oesophagus slender elongate extending anteriorly up to equatorial line leading to anteriorly directed saccular intestine, 0.174 x 0.14; intestine parallal with testes and in median line.

Testes two, oval, postovarian, parallal, on right side of intestine and in line with it, right outer testis immediately behind ovary, measuring 0.174 x 0.14 mm; left testis slightly overlapping inner border of right testis and right border of intestine on inner side, it measures, 0.182 x 0.133 mm; vas efferens of each testis leaves from its left prosterior border and join in the region of oesophagus to form vas defferens, the latter before entering the copulatory complex expands to form 'spermiducal vescile' [Oldhame 'false seminal vesicle'/vesicula seminalis externa(?)], it is thin walled spindle shaped structure, it enters cirrus sac and leads into vesicula seminallis which is nearly cylindrical and has wall slightly thicker than spermiducal vesicle, it continues into pars prostatica, surrounded by prostate glands, and is followed by ejaculatory duct; cirrus sac enclosing all these structures, cylindrical, well developed, it extends anterior to pharynx upto middle of oesophagus and measures0.38 x 0.102 mm. Genital opening 0.099 mm from posterior end.

Ovary oblong, 0.163 x 9.079 mm on right side immediately in front of right testis; oviduct leaves from right posterior border and joins shell gland complex in front of testis; vitelline follicles oval to rounded, large, 12 - 14 in number bunched on either side of posterior border of anterior sucker in front of constriction, two vitelline ducts from the vitelline gland travel posteriorly and join to form a common duct before joining shell gland complex, uterus on leaving shell gland complex ascends anteriorly upto anterior sucker and covers all area left of gonads and posteriorly upto cirrus sac, it descends from behind right side of inner testis to join large muscular metraterm, eggs light yellow, oval, 0.019 x 0.0114 mm in size. Excretory pore terminal, excretory vesicle tubular.

Host : Xenentodon cancila (Hamilton)

Location : Stomach

Locality : River Ken, District Banda (U.P)

DISCUSSION

The parasite described shows dinstict characters like the constriction immediately behind the anterior sucker forming a sort of a collar, presence of gonads in the prepharyngeal zone nearly in the first half of the body, testes being parallel and on the same side and in line with the intestine, presence of spermiducal vesicle (vesicula seminalis externa?)

and large vitelline follicles bunched in two groups near the posterior margin of anterior sucker. The spermiducal vesicle described in the parasite is similar to vesicula seminalis externa in Bucephatopsis sinhai Dayal, 1948 and the parasite differs from all the other known species in this character. However the worm differs from B. sinhai and all other known species in having a collar like constriction, position of gonads in prepharyngeal zone on the same side, parallel tests on the same side of intestine and parallel with intestine. In view of the distinct characters of the worm it is received in the genus Bucephalopsis Diesing 1855 as a new member and named Bucephalopsis bundeli n.sp. after the name of Bundelkhand region.

Family : Bucephalidae Poche, 1907

Sub family : Bucephalinae Nicoll, 1914

Genus : Bucephalopsis (Diesing, 1855) Nicoll, 1914

Bucephalopsis ramalingami n.sp.

(Plate VIII, Fig. 2)

Twenty two specimens of a fresh water fish, Xenentodon cancila (Hamilton) were collected from the river Ken in the district Banda and were examined for digenetic trematodes. Four of them were found infected with twelve of these gastrostomes. These were fixed and stained as described in previously described species. The species is named in honour of Prof. Ramalingam of Madras University, an eminent helminthologist of India.

DESCRIPTION

Small worm with nearly rounded anterior end, posterior end somewhat blunt, 1.235 mm long and 0.68 mm broad at equatorial line; cuticle armed with very fine minute spines distributed sparingly, anterior sucker discoid, muscular 0.268 x 0.228 mm in size; pharynx postequatorial, 0.081 x 0.098 mm; oesophagus broad, 0.319 mm long, directed obliquely and anteriorly makes a 'U' turn before joining the intestine,

Intestine median, equatorial, in line with anterior testis and away and immediately in front of pharynx, 0.228 x 0.174 mm in size.

Testes two, tandem, anterior testis equatorial between ovary and intestine, 0.228 x 0.129 mm in size, posterior testis smaller, immediately behind anterior testis and in line with pharynx, 0.269 x 0.201 mm in size; cirrus sac small, broad extending anteriorly anterior to pharynx to proximal margin of intestine vesicula seminalis and pars prostatica well developed, latter surrounded by prostrate glands and followed by ejaculatory duct; genital opening 0.170 mm from posterior end.

Ovary equatorial, on right side of anterior testis and slightly overlapped by it on its inner border, 0.190 mm long, 0.125 mm broad; oviduct from posterior inner border joins ootype immediately behind ovary in front of posterior testis; ootype surrounded by shell glands forming an oblong mass; large vitelline follicles 12 - 14 in number extend from lateral boader of anterior sucker upto line of gonads in first third of body, two vitelline ducts extend posteriorly and medially and join to form a common vitelline duct which joins ootype; uterus extends anteriorly occupies all the area anterior to gonads upto anterior sucker and on left side of intestine, and continues posteriorly between oesophagus and cirrus sac to

to join the metraterm which is well developed, muscular; eggs light yellow or brown, 0.0190 x 0.0114 mm. Excretory opening terminal, excretory vesicle Y-shaped.

Host	Xenontodon cancila (Hamilton)
Location	Stomach
Locality	River Ken, Banda

DISCUSSION

Bucephalopsis ramalingami n.sp. is characterised by the position of the ovary being lateral to anterior testis and in line with intestinal sac, cirrus sac reaching anterior to pharynx upto the beginning of intestinal sac, vitelline follicles being extended from lateral margin of anterior sucker upto anterior margin of ovary and anterior testis and the excretory vesicle being Y shaped. In possession of Y-shaped excretory vesicle the newly described worm resembles B. magnum Verma, 1936 and differs from all the other known species and B. ramalingami sp. nov. in this character. B. ramalingami n.sp. differs from B. magnum and other species of the genus in position of ovary being lateral to anterior testes and in line with intestinal sac and position of ootype being immediately anterior to posterior testis. The characters are sufficiently distinct to receive Bucephalopsis ramalingami n.sp. as a new member of the genus. This is the first report of any gasterostome from this region and also from district Banda (U.P).

Family : Bucephalidae Poche, 1907

Sub family : Bucephalinae Nicoll, 1914

Genus : Bucephalopsis (Diesing, 1855) Nicoll, 1914

Bucephalopsis gaurai Verma, 1936

(Plate IX, Figs 1-6)

A large number of worms of this species were collected from the intestine of a fresh water fish, Pseudentropius gaura (Hamilton), collected from Betwa river in the district Jhansi. Since there is great variability in the position of internal organs and considerable variations in the dimensions of the organs, a redescription of the species is given here to clear the things.

DESCRIPTION

Body elongated, slender small to medium sized, aspinose with its anterior part broad and posterior part narrow and rounded. It measures 2.45 - 5.40 x 0.90 - 2.1 mm in size. Anterior sucker sub terminal, circular or oval, 0.36 - 0.73 x 0.33 - 0.72 mm in size. Mouth in centre of body. Pharynx circular, equatorial, preequatorial or postequatorial, 0.15 - 0.25 mm from anterior extremity. Esophagus short and tubular. Intestine saccular, median or a little anterior to median plane. It measures 0.53 - 1.25 x 0.25 - 0.52 mm in size at 0.88 - 1.85 mm from anterior extremity.

Excretory pore at posterior extremity. Excretory bladder 'Y' shaped.

Genital pore close to posterior extremity, subterminal and surrounded by feebly developed sphincter muscles.

Testes globular or oval, entire, postovarian in same plane behind intestine on either side of pharynx or cirrus sac or on one side directly or obliquely tandem, overlapping or away from each other. The position and size of testes varies from specimen to specimen. Anterior testis lies from a little anterior to cirrus pouch upto middle region of intestine. It measures 0.20 - 0.60 x 0.25 - 0.42 mm in size at 0.76 - 2.80 mm from hind end of body. Posterior testis lies from middle of cirrus pouch upto level of hind end of intestine. It measures 0.30 . 0.48 x 0.25 - 0.50 mm in size at 0.73 - 1.75 mm from posterior extremity. Cirrus pouch large tubular extending from posterior end of body upto hind end of anterior testis; size and position varies from specimen to specimen; length of cirrus sac varies from 1/6th to 1/3rd of body length, measuring 0.75 - 1.2 x 0.20 - 0.30 mm in size. Vesicula seminalis oval and 0.51 - 1.15 x 0.06 - 0.12 mm in size. Pars prostatica large, globular, 0.08 - 0.21 x 0.05 - 0.10 mm in size, opening into a short ejaculatory duct, 0.11 - 0.30 mm in length. A large number of proslate gland cells fill up space in cirrus sac around vesicula seminalis and pars prostatica.

Ovary oval, entrie, pretesticular situated on right or left side of intestine, anterior or posterior to it, measuring 0.23 - 0.46 x 0.24 - 0.35 mm in size at 1.15 - 3.11 mm from posterior extremity. From its posterior side arises oviduct leading to ootype. Mehtlis' gland cells surrounding ootype forming a compact oval mass at hind end of ovary and partly covering it. Vitelline glands rounded, follicular, entire or bilobed extending from anterior end of oral sucker or a little posterior to it upto middle of intestine or a little posterior to it. Follicles from 12 - 20 on each side of body. Two vitelline ducts on either side meet and form a yolk reservoir before opening at ootype. Uterus arises from ootype and extends anteriorly forming a number of coils upto anterior end of oral sucker, then turn towards posterior side to open at genital sinus. Eggs oval, non operculated, 0.021 - 0.42 x 0.015 - 0 024 mm in size.

Host : Pseudentropius gurua (Hamilton)

Location : Stomach

Locality : Betwa river, District Jhansi (U.P)

DISCUSSION

Verma (1936) described 5 species of the genus Bucephalopsis viz. B. fusiformis, B. garuai, B. magnum, B. confusus and B. minimus from the intestine of fresh water fishes at Allahabad. Bhalerao (1937) considered B. magmum,

B. confusus and B. minimus as synonyms of B. garuai. The minor differences pointed out as existing between the species and the last three can be ascribed either to difference in age or individual variations. Nagaty (1937) considered B. garuai as a distinct species on the basis of bilobed or double nature of vitelline glands. Srivastava (1938) considered B. magnum as a valid species but maintains that B. contusus and B. minimus are synonymous to B. garuai. Gupta (1956) while redescribing B. magnum and B. karvei agreed with Nagaty in considering B. belonca as a synonym of B. karvei. The author is in agreement with Bhalerao (1937) in considering B. confusus. B. mininus and B. magnum to be synonym of B. garuai and does not agree with Nagaty, Srivastava and Gupta in considering B. garuai as distinct on the basis of bilobed or double nature of vitellaria as it is a variable depicted in figures.

The present specimen in my collection forms the first host and locality record from this region.

Family : Bucephalidae Poche, 1907

Sub family : Bucephalinae Nicoll, 1914

Genus : Neobucephalopsis Dayal, 1948

Neobucephalopsis chauhani n.sp.

(Plate X, Fig. 1)

Only two specimens of this gastrostome trematode were collected from the small intestine of a fresh water fish, Clupiosoma garua at Lalitpur (U.P).

The fish was catched from the river Betwa in district Lalitpur. The two specimens were of almost equal size and on their detailed study it was observed that they represent a hitherto unknown species of the genus Neobucephalopsis Dayal, 1948.

The following description is based only on the stained and whole mount of only one specimen. All measurements are given in millimeters.

DESCRIPTION

Small, linguiform, aspinose body, 3.01 long and 1.26 in maximum breadth in the region of ovary. Rhynchus (anterior sucker) large, subterminal, circular in outline, 0.42x0.40. Mouth opening immediately pre-equatorial, 1.46 from anterior end. Pharynx 0.11 x 0.16. Oesophagus short and anteriorly directed. Intestine 0.42 long, immediately postovarian,

saccular and tubular, showing characteristic annulations. Genital pore postero-ventral in front of excretory pore, which is postero-terminal.

Gonads on the same side (left) of the median line. Testes two, almost tandem, postovarian; anterior testis 0.38 x 0.27, slightly larger than the posterior testis, lobed and irregular, anterior margin touching the equator; posterior 0.35 x 0.20 and with entire margin. Cirrus sac long and cylindrical, 0.61 x 0;18 (about 20 % of body length), extends from hind end of body to the level of middle of posterior testis, and contains a small vesicula seminalis, a large pars prostatica and a short ejaculatory duct; pars prostatica surrounded by a pack of prostate glands; genital sinus broad.

Ovary roughly pear-shaped, 0.29x0.26 in size, and 0.88 (29%) from anterior end of body, immediately antero-lateral to the front end of intestine, Mehlis' gland complex immediately behind ovary; small but distinct receptaculum seminis, 0.014 x 0.003 in size; Vitellaria follicular with 14 - 16 lobed follicles on each side between the anterior sucker and ovary. Uterus arises from ootype, ascends up for a small distance cephalad to ovary, bends down to run up to

region behind the posterior testis, ascends up again as a coiled tube on the right side of the body to reach up to the middle of the anterior sucker, and then comes down as a highly convoluted tube, running medial to the cirrus sac as a metraterm to open into the genital atrium. Eggs thin-shelled, yellowish brown, and 0.24 x 0.012 in size.

Host : Clupiosoma garua

Locality : Betwa river, District Lalitpur

Location : Small intestine

DISCUSSION

The genus Neobucephalopsis was created by Dayal in 1948 to accommodate Bucephalopsis like trematodes with a distinct receptaculum seminis. In a recent review of the Indian gasterostomes, Srivastava and Chauhan (1972) have considered Neobucephalopsis as cogeneric with the genus Bucephalopsis. They do not consider the presence or absence of receptaculum seminis as an important character, because their study has revealed that receptaculum seminis is present in some specimens, whereas it is not discernible in other specimens of the same series due to its thin and transparent nature and massive development of shell glands. The authors find it difficult to agree to this contention, as the failure to observe the presence of a receptaculum seminis does not mean its absence, and the presence or absence of a structure never

carries the same meaning. If a structure is not discernible in whole preparations, its presence can be verified in sections of the material. This may be the reason that Yamaguti (1958) has accepted Neobucephalopsis as a valid genus.

Apart from the type species Neobucephalopsis bagarius Dayal,1948, three other species N. gauhatiensis, N. eutropiichthis and N. pseudotropei have been described by Gupta (1953) from India. Following the key given by Gupta (1953), the form under reference is comparable with N. pseudotropei in having an ovary smaller than testes, and the cirrus sac not extending up to the anterior testis. However, on making a strict comparison of the two species (see Table), the new form differs from N. pseudotropei in having a sacculated intestine with a characteristic annulated appearance, the more anterior position of the ovary, relatively shorter size of the cirrus sac, and the extent of the uterus. If the length of the cirrus sac is not taken into strict consideration, the new form becomes comparable with N. bagarius Dayal 1948. However, the length/breadth ratio the position of anterior testis, form and disposition of the intestinal sac, and the extent of the cirrus sac (see Table) make the comparison of N. bagarius and the new form difficult. Therefore, the form under discussion is considered to be a new species, and it is proposed to name it as Neobucephalopsis chauhani in honour of Dr. B.S. Chauhan, an eminent Zoologist and one of the founder of helminthology in India.

TABLE SHOWING THE COMPARISON OF *NEOBUCEPHALOPSIS CHAUHANI* N.SP. WITH *NEOBUCEPHALOPSIS BAGARIUS* DAYAL, 1948 AND *NEOBUCEPHALOPSIS PSEUDOTROPEI* GUPTA 1953

Structure compared	*N. bagarius*	*N. pseudotropes*	*N. chauhani* n.sp.
Skin	spinose	spinose	aspinose
Length/breadth	4.2	2.9	2.4
% distance of mouth opening from anterior end	45.5	50.6	48.5
Anterior testis Posterior testis	1.18 (anterior testis slightly larger)	1.04 (testes almost equal)	1.2 (anterior testis distinctly larger)
Intestine	sac like and lying transversely	simple sac	saccular, annualated and backwardly directed
Ovary	quite anterior to intestine	in level with pharynx	antero-lateral to front end of intestine
% distance of ovary from anterior end	50.6	47	29
Length of cirrus sac in relation to body length	1/3	1/4	1/5
Anterior extent of cirrus sac	Upto the anterior testis	Hind end of posterior testis	Middle of posterior testis.

A key to species of Neobucephalopsis is given below.

KEY TO THE SPECIES OF NEOBUCEPHALOPSIS

1.	Testes one on either side of cirrus sac	N. gauhatiensis Gupta, 1953
	Testes on one side of cirrus sac	2
2.	Ovary larger than testes	N. eutropiichthis Gupta, 1953
	Ovary smaller than testes	3
3.	Ovary in level with pharynx	N. pseudotropei Gupta 1953
	Ovary anterior to intestine	4
4.	Cirrus sac extending up to anterior testis and about 1/3 of the body length	N. bagarius Dayal, 1948
	Cirrus sac extending up to posterior testis and about 1/5 of the body length	N. chauhani n.sp.

Family : Hemiuridae Lühe, 1901

Sub family : Derogenetinae Odher, 1927

Genus : Genarchopsis Ozaki, 1925
(Syn. Progonus Looss, 1899 preoccupied)

Genarchopsis jaini n.sp.

(Plate XI, Figs 1-5)

A large number of digenetic trematodes belonging to this species were recovered from the stomach of a fresh water fish, Channa punctatus (Bloch.). The fish was obtained from the fish market at Banda. On enquiry, the fish shop owner told that the fishes are a part of catch from the river Ken. On detailed study the worms were found belonging to a new species and are described here.

DESCRIPTION

Body fusiform with rounded extremities, 1.3 - 3.33 x 0.68 - 1.02 mm in size. Oral sucker subterminal, oval, 0.22 - 0.45 x 0.27 - 0.46 mm in size. Prepharynx absent; pharynx well developed, 0.05 - 0.12 x 0.06 - 0.16 mm in size; esophagus absent; esophageal pouch arises from junction of pharynx and intestinal bifurcation, 0.12 - 0.22 x 0.06 - 0.07 mm in size. Intestinal caeca crenated in outline, run in a wavy course to hind end of body and united together in vitellaria

region. Ventral sucker larger than oral sucker, spherical, equatorial or postequatorial, 0.47 - 0.74 mm in diameter at 0.82 - 1.83 mm from anterior extremity.

Genital pore median, close behind pharynx at a distance of 0.47 - 0.57 mm from anterior extremity.

Excretory pore dorsally at posterior end of body. Excretory bladder Y-shaped with an unbranched median stem dividing into two cornua extending upto ventral sucker uniting dorsal to pharynx.

Testes oval, postacetabular, subequal, entire, caecal and somewhat symmetrical or oblique in position. Left testis 0.13 - 0.31 x 0.10 - 0.26 mm in size and lies slightly nearer ventral sucker than right testis which measures 0.10 - 0.24 x 0.09 - 0.24 mm in size. Cirrus sac absent. Vesicula seminalis elongated. S-shaped or somewhat winding in a coiled tube filled with sperms lying free in parenchyma far anterior to acetabulum and close to intestinal bifurcation. It measures 0.40 - 0.55 x 0.05 - 0.06 mm in size. Pars prostatica tubular 0.06 - 0.1 mm long enclosed in a thin walled sac surrounded by a large number of prostate gland cells. Ejaculatory duct, 0.05 - 0.06 mm long opening in terminal part of uterus.

Ovary oval, postacetabular, entire, larger or smaller than testes, either close or away behind right testis. It

measures 0.13 - 0.20 x 0.12 - 0.22 mm in size at 0.25 - 0.47 mm from hind end of body. Oviduct arises from right side of ovary and opens at ootype. Receptaculum seminis well developed oval, lying postero dorsal to ovary 0.06 - 0.15 x 0.13 - 0.15 mm in size. Vitellaria consists of two large compact or lobed masses lying symmetrically or obliquely tandem in posterior region of body. Right vitelline gland measures, 0.17 - 0.23 x 0.09 - 0.15 mm in size while left vitelline gland measures 0.13 - 0.23 x 0.12 - 0.18 mm in size. Vitelline ducts arise from each vitelline gland and the two unite each other before opening at ootype. It lies just behind ovary and partly overlapped by it, 0.06 - 0.14 x 0.11 - 0.15 mm in size. Uterus arises from dorsal side of ootype and forms closely packed transversely coils occupying mostly preacetabular area. The coils of the uterus are mainly internal and external to caeca. The terminal part of uterus receives ejaculatory duct forming hermaphrodite duct which opens at genital pore. Eggs oval with a polar filament at one end, 0.035 - 0.06 mm in length. Eggs measures 0.04 - 0.05 x 0.02 - 0.25 mm in size.

DISCUSSION

Srivastava (1933) considered that the genus *Genarchopsis* Ozaki, 1925 is identical and synonymous with the genus *Progonus* Looss, 1899. In the same year he created another genus *Ophiocorchis* with the type species *O. lobatum* under the sub family Derogenetinae of the family Hemiuridae Luhe, 1901. He distinguished the genus *Ophiocorchis* from *Progonus* in the

possession of a well developed globular parsprostatica, a large and highly muscular metraterm, a protrusible ductus hermaphroditicus and oesophageal pouch. Yamaguti (1958) considered the genera Progonus Looss, 1899; Genarches Looss 1902 and Ophiocorchis Srivastava, 1933 as a synonym of Genarchopsis Ozaki, 1925. The author is in agreement with Yamaguti as the characters separating the genus Ophiocorchis from Progonus are variable.

The new form is referred to the genus Genarchopsis Ozaki, 1925 of which seven species are known from fresh water fishes of India. The new form differs from all the known forms of the genus in the possession of a well developed receptaculum seminis and in having genital pore close behind the pharynx. The new form resembles G. lobatum (syn. Ophiocorchis lobatum); G. singularis (syn. O. singularis) and G. faruquis (syn. O. faruquis (syn. O. faruquis) in the possession of an oesophageal pouch. The new form differs from G. lobatum and G. singularis in having testes symmetrical instead of one behind the other. Further the new form differs from G. lobatum in having entire or slightly lobed vitellaria instead of lobed glands and from G. singularis in the non extension of uterine coils upto hind end of vitellaria. The new form bears a very close resemblance to G. faruquis but differs from it in not having Mehlis' gland complex anterior

to ovary. These differences are sufficient to create a new species G. jaini n.sp., It is named in honour of Dr. S.P. Jain, D.Sc. an eminent helminthologist.

Host : Channa punctatus (Bloch.)

Location : Stomach

Locality : Ken river, District Banda.

Family : Hemiuridae Lühe, 1901

Sub family : Derogenetinae Odhner, 1927

Genus : Genarchopsis Ozaki, 1925

(Syn. Progonus Looss, 1899 preoccupied)

Genarchopsis goppo (Tubangui) Ozaki, 1925

(Plate XII, Fig. 1)

On several occasions the fish species Channa punctatus (Block) = Ophiocephalus punctatus (Bloch), the smaller form and C. striatus (Bloch), the larger form, collected from fish market at Hamirpur revealed the presence of a parasite belonging to the species Genarchopsis goppa (Tubangui) Ozaki, 1925, the site of infection being intestine. The number of worms collected from a host was usually one or two . Therefore an attempt has been made to restudy these specimens for variations and to discuss the validity of various species.

DESCRIPTION

The account is based on about three dozen mounted specimens (both mature and immature and sectioned) collected from Channa punctatus, C. striatus, R. cyanophlyctis and T. piscator. The aspinose body (Fig. 1) is cylindrical, elongate oval with an attenuated anterior and a blunt posterior end measuring 2.31 - 2.65 mm x 0.63 - 0.91 mm.

The oral sucker is subterminal, oval and measures 0.14 - 0.26 mm x 0.23 - 0.32 mm. The ventral sucker is well developed, larger than oral sucker, located in the middle third of body, sometimes displaced during fixation and measures 0.42 - 0.67 mm x 0.45 - 0.68 mm in size. The prepharynx is absence, the pharynx is round to oval, at times overlapped by oral sucker and measures 0.06 - 0.08 mm x 0.08 - 0.09 mm. A small oesophagus, better seen in live specimens, measures 0.06 - 0.08 mm. In fixed specimens, however, due to contraction it seems to be absent. Further, a small pouch (oesophagean pouch of Srivastava, 1933), not well developed in some specimens, is present at the level of the intestinal bifurcation. The oesophagus, when studied in a live contracted specimen, assumes a pouch or a bulb shape at the intestinal bifurcation. Further, the histological details of this region, as revealed by serial sections, show identical structure of oesophageal pouch and intestinal caeca. The intestinal caeca is sinuous, with its outer margin smooth, crenated or lobed and unite with one another in the hind region of the body.

The roughly equal testes are round, elongate or oval in shape, symetrically or slightly asymetrically located behind the ventral sucker. They are mostly intercaecal but sometimes, overlapped by the intestinal caeca. The testes measure 0.16 - 0.31 mm x 0.12 - 0.16 mm. A thick walled convoluted vesicula

seminalis with well marked lumen inside, is located free in the parenchyma. The tubular pars prostatica is sometimes curved and surrounded by well developed prostate gland cells. It opens at the terminal part of the metraterm by short ejaculatory duct. No sac like structure, as described by Gupta (1951) in some species of Genarchopsis, surrounds the vesicula seminalis or pars prostatica.

The round or oval ovary is median or dextrally placed in between the testes and vitelline follicles. The Mehlis' gland complex is well developed and situated near or slightly away from the ovary. In young specimens, however, it is poorly developed. The short oviduct opens at the ootype from where a prominent Laurer's canal arises. The receptaculum seminis uterinum, simulating a true receptaculum seminis, is present. The uterus is transversally arranged in the intercaecal space but also extends in the extracaecal field or overlapping the intestinal caeca upto the shell gland mass. Anterior to the ventral sucker, it forms a short metraterm behind the intestinal bifuration in which opens the pars prostatica to give rise a ductus hermaphroditicus which terminally opens by a short, stumpy, contractile, genital papilla, well marked in some specimens into a genital atrium. The genital pore and genital papilla have striated cuticle. Further, the genital pore is surrounded by glands and is variable in its position. In well pressed specimens it is

medially opposed to the intestinal bifurcation but in contracted specimens, lie even anteriorly, slightly laterial to the oesophageal pouch or at the level of the oesophagus. The eggs are oval, operculated, filamentous measuring 0.016 - 064 x 0.023 - 0.031 mm, the long polar filaments measure 0.19 - 0.31 mm.

The vitelline follicles consist of two glandular masses located roughly symmetrical or asymmetrical behind the ovary. They are entire, lobed or with crenated margins. The common vitelline duct, from the vitelline reservoir, opens at the ootype.

The 'Y' shaped excretory bladder opens out by a terminal excretory pore which is surrounded by deeply staining cells. The excretory canals, one on each side of the body, extend upto the pharyngeal region where they unite together.

Host : Channa punctatus (Bloch)

Location : Intestine

Locality : River, Betwa, District Hamirpur

DISCUSSION

The genus Genorchopsis was erected by Ozaki (1925) with G. goppo as the type species. Earlier Looss (1899) created the genus Progonus to include Genorchopsis mulleri Levinson,

1881. Subsequently, Srivastava (1933) regarded Genorchopsis as synonym of Progonus and discribed P. piscicola and P. ovocaudatum as additional species. Further, Srivastava (1933) created the genus Ophiochorchis to include O. lobatum and O. singularis on account of the presence of an oesophageal pouch, Gupta (1951) added three more species viz, O. dasus, O. indicus and O. faruquis and amended the diagonosis of the genus Ophiochorchis. Chauhan (1953) in the comprehensive work on the family Himuroidae maintained the genus Genorchopsis, Progonus and Ophiochorchis though he doubted the validity of certain species of the genus Genorchopsis and Ophiochorchis. Further, he pointed out the wrong nomenclature coined by Gupta (1951) for O. dasus and O. faruquis. Skrjabin et al (1955) considered the genus Progonus and Ophiochorchis synonym of Genercheș and maintained the genus Ophiochorchis and its five species valid because of presence of oesophageal pouch. Yamaguti (1958) in his monograph 'Systema Helminthum' considered the genus Genorchopsis valid with Progonus and Ophiochorchis as its synonym, taking in view the caudal anastmosis as common feature in the three genera. He further enlisted 11 species under the genus Genorchopsis of which eight were transferred from the genera Ophiochorchis and Progonus. The writer fully agrees with Yamaguti (1958) and regards Ophiochorchis and Progonus and as synonym of Genorchopsis. Dwivedi (1965) described the first Indian species from an amphibian host. In 1966, two more new species were added by

Gupta and Chakrabarti and Agrawal respectively, of which the former was from a snake. In the same year, Rai and Pande (1966) for the first time pointed out the variability of certain specific characters used by earlier workers and doubted the validity of some species. Anjaneylu (1967) described in detail, the female reproductive system of G. punctati Agarwal, 1966. Subsequently, Kakaji (1969) added two more species from fishes of Lucknow. Rai (1971) briefly discussed the validity of some of the Indian species. Bashirullah and Elahi (1972) added two more species viz. G. ozaki and G. bangladesensis from Channa punctatus at Dacca.

Yamaguti (1958) enlisted the following species under the genus Genorchopsis:—

G. goppa (Ozaki, 1925) type species; G. gigi Yamaguti, 1919, G. anguillae Yamaguti, 1938; G. mulleri (Levinson,1818) G. lobatum (Srivastava, 1933); G. ovocaudatum (Srivastava,1933) G. piscicola (Srivastava, 1933); G. singularis (Srivastava, 1933); G. dasus (Gupta,1951); G. faruquis (Gupta,1951) and G. indicus (Gupta, 1951).

During recent years following more species have been added :

G. melanostictus Dwivedi, 1965; G. thapari Gupta & Chakrabarti, 1966; G. punctati Agrawal, 1966; G. cuchiai

Kakaji, 1969; G. cameroni Kakaji, 1969, G. ozakii Bashirullah and Elahi, 1972; G. bangladesensis Bashirullah and Elahi,1972.

Thus, till now the genus Genorchopsis includes 18 species of which 8 have been transferred from other genera. On perusal of literature it is evident that the characters used by earlier workers to differentiate the species are follows :

1. Size of body
2. Ratio of suckers
3. Position of acetabulum
4. Presence or absence of oesophagus
5. Presence or absence of oesophageal pouch
6. Position of testes
7. Presence or absence of cirrus sac
8. Relative size of the vesicula seminalis and pars prostatica
9. Uncoiled nature of pars prostatica
10. Presence or absence of receptaculum seminis
11. Presence or absence of Mehlis' glands
12. Position of Mehlis' glands
13. Position and shape of vitelline follicles
14. Extracaecal or intercaecal position and extension of uterine coils
15. Presence or absence of a genital papilla
16. Position of genital pore and
17. Presence of a hermaphroditic duct

A review of the literature and a thorough study of the available specimens at the disposal of the writer, studied alive, stained and mounted and serial sections have revealed that the so called above stated diagnostic features stressed in an identification of species utilised by earlier workers are highly variable, particularly in consequence of age and maturity of the specimens and fixation and are in intergrading series. Further, a true cirrus sac and receptaculum seminis as described by Gupta and Chakrabarti (1971) and Agrawal (1972), respectively are doubted as these structures are absent in the genus Genorchopsis. In the light of above study, an attempt has been made to re-study various species for their validity.

1. G. lobatum (Srivastava, 1933): Srivastava (1933) described G. lobatum from the stomach of Ophiocephalus striatus (now known as Channa striatus) at Lucknow. Gupta (1951), in his key to the species, differentiated the form from other related species by the shape of vitelline gland and by extension of uterine coils. A careful comparison of the account of G. lobatum and G. goppo shows that the characters used by Srivastava (1933) in distinguishing G. lobatum from other known species are more or less similar to G. goppo and are in itergrading series. Therefore, the writer regards G. lobatum as synonym of G. goppo.

2. G. piscicola (Srivastava, 1933): Srivastava (1933) described the species from the stomach of Ophiocephalus punctatus (now regarded as Channa punctatus) at Allahabad. It is characterised by larger size, position of acetabulum, ratio of suckers, position of gonads, vitellaria, genital pore and extension of uterus. As these features are variable, the writer regards G. piscicola as synonym of G. goppo.

3. Genorchopsis singularis Srivastava, 1933: Srivastava (1933) described this species (on a single specimen) from the intestine of a Ophiocephalus striatus at Sitapur. However, Chauhan (1953) doubted the validity of the species and pointed out its affinity to G. goppo. Subsequently, Rai (1971) considered it a synonym of G. goppo. The writer reinforce the doubts of Chauhan (1953) and agrees with Rai (1971) and regards G. singularis as a synonym of G. goppo.

4. G. ovocaudatum (Srivastava, 1933) Manter, 1936 : Srivastava (1933) described this species from the intestine of Ophiocephalus punctatus at Allahabad. It is characterised by smaller size of the body, position of the acetabulum, course of the intestinal ceaca, caudal position of the testes, smaller size of the shell gland mass, symmetrical position of vitellaria and extension of the uterine coils. Subsequently, Chauhan (1953) doubted the validity of the species and considered a synonym of G. piscocola. Rai (1971) called it a synonym G. goppo to which the writer also agrees.

5. Genorchopsis dasus (Gupta,1951): Gupta (1951) described it from the stomach of Ophiocephalus punctatus (Bloch) collected at Saharanpur. One mature and numerous immature specimens were collected but the description is based on the mature specimen. The species is distinguished from O. singularis and O. labatum by the presence of an oesophagus, by absence of oesophageal pouch, non extension of uterine coils behind shell gland mass, relative size of vesicula seminalis and pars prostatica, presence of a hermaphroditic duct and position of the genital pore. As stated earlier, almost all these characters are variable, depending on the maturity of the specimens and degree of contraction at the time of fixation as the muscular fluke has a mobile preacetabular portion. So creation of a species on such variable feature is uncalled for. Therefore, G. dasus (Gupta,1951) is regarded,as pointed out by Rai (1971), a synonym of G. goppo (Tubangui).

6. Genorchopis indicus (Gupta,1951): Gupta (1951) created the species (on a number of specimens) from the stomach of O. punctatus (Bloch) examined at Lucknow and Saharanpur. This species is distinguished by position of genital pore, position of vitellaria and relative size and position of the other body organ. On comparison of the account and figure of G. indicus one finds a number of discrepencies in the two, the important being the position of genital pore. The writer has stated,

'the genital pore lies just behind the oral sucker on the left or the right side of the pharynx' but in the fig, (Fig. 4 page 46) it has been shown to be located in the middle of the oral sucker, definitely ahead of the pharynx. Similiarly, the vitelline follicles, as stated by an author consist of two large lobed bodies, which is not so in the figure. Further, the present writer fails to note any appreciable difference in the relative size and position of body organs of G, indicus and G. goppo as they appeared in intergrading series. Thus,all these characters are untenable for specific diagnosis. Earlier, Chauhan (1953) rightly doubted the validity of G. indicus (Gupta, 1951). Therefore, G. indicus (Gupta, 1951) is regarded, as pointed out by Rai (1971), a synonym of G. goppo.

7. Genorchopsis melanostictus Dwivedi, 1965: Dwivedi (1965) described this species from the stomach of a Bufo melanostictus at Jabalpur. The account is based on two specimens. The species has been differentiated from others by the position of the genital pore, lobed vitellaria, position and ratio of suckers, well spacious genital atrium, tubular vesicula seminalis, long tubular pars prostatica and semilunar genital pore which are variable features. Therefore, G. melanostictus is considered synonym of G. goppo and Bufo melanostictus is added to the host list of the G. goppo.

8. G. jaini n.sp. (included in this thesis): The species in characterised by presence of well developed receptaculum seminis, position of genital pore close behind the pharynx, an oesophageal pouch, symmetrical testes, entire or slightly lobed vetellaria, non extension of uterine coils upto the hind end of the vitellaria and got having MeMehlis' gland complex anterior to the ovary.

9. G. thapari Gupta and Chakrabarti (1966): Gupta et al. (1966) described this species from the intestine of an unidentified snake at Lucknow. The description is based on four immature specimens. The species is characterised by possession of well developed cirrus pouch, presence of an oesophageal pouch, position of genital pore, uncoiled pars prostatica, absence of genital papilla, intercaecal position of testes, presence of shell gland complex posterior to ovary and the position of testes.

Of these, except for presence of cirrus pouch, almost all features are variable and insignificant for specific identification. Further, the presence or absence of cirrus pouch has a generic status as earlier pointed by Lal (1938). With a view to confirm the presence of cirrus pouch in G. thapari, the writer dissected a number of specimens of two common snakes viz. T. piseator and T. mueosus locally available. Fortunately an immature specimen of Genorchopsis

species was collected from the intestine of T. piscator. On subsequent study, it revealed that the specimen resembles G. thapari in almost all the body features except for the absence of a cirrus sac. Consequently, the writer doubts the presence of a cirrus sac in G. thapari. What has been described as cirrus sac in G. thapari is an erroneous observation made by joint authors. The writer is of opinion that type material of G. thapari should be restudied to ascertain the presence of a true cirrus sac and if so,it should be transferred to another genus. Further, the creation of species on characters like the position of shell gland complex, position of testes and uncoiled pars prostatica is not desirable. Therefore, G. thapari is tentatively considered synonym of G. goppo and T. piscator is added to the host list of G. goppo.

10. G. cuchiai Kakaji, 1969: Kakaji (1969) described (on two specimens) this species from the stomach of Amphipnous cuchia (Ham.) which was collected from District Muzaffarnagar (U.P). The species has been differentiated by absence of receptaculum seminis, position of genital pore, extension of uterine coils and absence of Mehlis' glands. The uterine coils as stated by Kakaji, (1969) are intercaecal and extracaecal in position and are similar to G. goppo. In her diagrames (Fig. 11 and page 74) Kakaji (1969) has definitely drawn an ootype complex surrounded by Mehlis' glands. Further

in the writer's opinion the presence or absence of Mehlis' glands is quite unreliable feature for establishing a species as it depends on the maturity and age of the worm. The absence of receptaculum seminis, as stated by Kakaji (1969) is as usual in G. goppo. The position of genital pore is also a variable feature as described by the present writer. Further the measurements of the body organs of G. cuchiai are more or less similar to G. goppo. Therefore, G. cuchiai is regarded as synonym of G. goppo and A. cuchia is added as additional host of G. goppo.

11. G. cameroni Kakaji, 1969: Kakaji (1969) described G. cameroni (on two specimens) from the intestine of Mystus seenghala at Lucknow. The species is characterised by extra-caecal extension of uterine coils, position of genital pore and testes overlapping intestinal caeca, are more or less similiar to some specimens of G. goppo in the possession of writer. Further, there is discrepancy in account and figure of G. cameroni. Kakaji (1969) has stated the testis as "testis oval, post acetabular, entire nearly equal, symmetrical and overlapping intestinal ceaca" but in the figure (Fig. 22 page 77) the position of right testis is intercaecal and quite apart from the intestinal caeca.

Therefore, G. cameroni is considered synonym of G. goppo and Mystus seenghala is added as additional host for G. goppo.

12. G. ozakii Basirullah and Elahi, 1972: The species was described by Basirullah et al. (1972), from the intestine of Channa punctatus at Dacca. However, the description is based on single specimen. The species is characterised by sucker ratio, position of testes, ovary and vitellaria and smaller oesophageal pouch, which are, as stated earlier, variable features. Therefore, G. ozakii is considered synonym of G. goppo.

13. G. bangladesensis Basirullah and Elahi, 1972: The species has been described on single specimen from the intestine of Channa punctatus at Dacca. It is characterised by ratio of suckers, shape of intestinal caeca and position of testes and vitellaria which are variable features. Therefore, G. bangladesensis is regarded as synonym of G. goppo.

G. goppo (Tubangui) Ozaki, 1925 = G. lobatum, G. ovocaudatum, G. piscicola, G. singularis, G. dasus, G. foruguis, G. indica, G. melanostictus, G. thapari, G. cuchiai, G. cameroni, G. ozakii and G. bangladesensis.

Hosts : Channa striatus, Channa punctatus, Amphipnuous cuchia, Mystus seenghala, Bufo melanostictus, Rana cyanophyctis and Tropiodonotus piscator.

Family : Paramphistomidae Fischoeder, 1901

Sub family : Caballeroiinae Yamaguti, 1971

Genus : Caballeroia Thapar, 1960

Caballeroia chauhani n.sp.

(Plate XIII, Fig. 1)

During the course of study of trematode parasites of fishes of Betwa and Ken rivers in the Bundelkhand region, the author came across with eleven specimens collected from the intestine a fresh water fish, Macrognathus aculeatus (Bloch), procured from a catch in Betwa river in the district Jhansi. These specimens on detailed study were found to constitute a new species belonging to the genus Caballeroia Thapar, 1960. It is designated as C. chauhani n.sp. in honour of Dr. B.S. Chauhan, an eminent Helminthologist of India.

The new species is described herewith alongwith a review of the status of the genus and its existing species, viz. C. indica Thapar, 1960 and C. bhavani (Achan, 1956) Devraj, 1972. The generic and sub family diagnosis have also been modified in the light of present observations.

DESCRIPTION

Body elongate, attenuated anteriorly and rounded posteriorly, measures 4.32 - 4.97 x 1.148 - 1.248 mm in

maximum width in post equatorial region. Anterior end bears small conical papillae arranged in 10 - 12 circular rows upto end of oral pouch leaving rest of the body smooth. Oral sucker subterminal, 0.168 - 0.25 mm in diameter, with long claviform paired oral pouch on either side of the oesophagus, 0.25 mm in length. Pharynx is absent. Mouth directly leads to long, narrow oesophagus which broadens into muscular oesophageal bulb before it bifurcates into two caeca. Caeca are sinonus and terminate some distance anterior to acetabulum, at times asymmetrical. Acetabulum ventroterminal, smaller than posterior body width 0.45 - 0.53 mm in diameter.

Testes two, preequatorial, just below the caecal bifurcation, intercaecal, symmetrical or oblique, entire with lateral sides almost touching or overreaching the caeca, measure 0.518 - 0.602 mm x 0.435 - 0.518 mm and 0.588 - 0.700 mm x 0.0350 - 0.416 mm respectively. Elongated pear shaped cirrus sac is placed just below the caecal bifurcation, measures 0.160 - 0.350 mm x 0.154 - 0.182 mm is think walled and encloses coiled vesicula seminalis interna and cylindrical cirrus. Vesicula seminalis externa is long and coiled. Genital pore is bifurcal or just prebifurcal, slightly towards right side and is guarded by a genital sucker.

Ovary is small, round, placed in median field in between the caecal ends and acetabulum near posterior extremity, measures 0.120 - 0.140 mm in diameter. Shell gland mass is

just posterior to ovary. Receptaculum seminis and Laurer's canal are present, vitelline follicles are internally placed in extra caecal fields, at times over lapping the caeca and extend from some distance anterior to ovary becoming U-shaped in posterior zone (almost contiguous): Vitelline ducts of the two sides meet to form a common vitelline reservoir from which a common vitelline duct joins the Ootype. Uterus extensive, intercaecal, the loops passing through intertesticular space in specimens where two testes do not overlap. Eggs are embryonate, cylindrical, 0.084 - 0.168 mm x 0.042 - 0.070 mm. Uterine eggs are smaller.

Excretory bladder saccular, just anterior to acetabulum. Two excretory canals start from either side of the bladder and reach upto the oral sucker. Excretory pore is dorso-subterminal. One pair of lymphatic vessels could be observed in our specimens.

Host : Macrognathus aculeatus (Bloch)

Location : Intestine

Locality : Betwa river, District Jhansi.

DISCUSSION

Thapar (1960) described the genus Caballeroia to accomodate his new species C. indica collected from Cirrhina fuleagel caught at Tungbhadra Dam. He did not assign his

new genus to any of the sub families of the family Paramphistomidae. Mukherjee and Chauhan (1967) though commented about non-assignment of this genus to any of the existing sub families but prefered to maintain status quo. Yamaguti (1971) erected a new sub family Caballeroiinae for this genus. Devraj (1972) unaware of Yamaguti's allocation proposed Caballeroinae a new sub family of this genus. Srivastava (1982) accepted genus Caballeroia, under sub family Caballeroiinae Yamaguti, 1971 and suppressed Caballeroinae Devraj, 1972 as Junior synonym. Under the genus Caballeroia he accepted two species, viz. C. indica Thapar, 1960 and C. bhavani (Achan, 1956) with the remark that the two species might be identical.

Genus Caballeroia Thapar, 1960 so far contains two species viz. C. indica Thapar, 1960, the type species collected from Cirrhina fulangel caught at Tungabhadra Dam, and C. bhavani (Achan, 1956) Devraj, 1972 parasitic in the intestine of Barbus hexagonolepis and B. carnaticus from Bhavnisagar Reservoir. The latter species was originally described as Nicolidiscus bhavani by Achan (1956) under the sub family Nicollodiscinae. Devraj (1972) redescribed this species and transferred it to the genus Caballeroia. Since then Caballeroia chauhani sp. nov. is the third species to be added to this genus. The new species differs from C. indica and C. bhavani in having oesophageal bulb, shorter caeca

terminating some distance anterior to acetabulum (vs caeca terminate in the region of acetabulum); 10 - 12 circular rows of papillae in the region of oral sucker and oral pouch (vs 5 rows in C. indica and 8 - 9 rows in C. bhavani; comparatively smaller acetabulum, 0.45 - 0.53 in diameter (vs 1.05 x 0.81 in C. bhavani and 1.0 in diameter in C.indica) limited distribution of vitellaria becoming contiguous in postovarian zone (vs in C. indica and C. bhavani extend from middle of caeca to its end not becoming contiguous posteriorly) presence of genital sucker and a pair of lyphatic canals.

Devraj (1972) described Y-shaped excretory bladder in C. bhavani but in my specimens as well as in C.indica it is saccular.

The new species is unique in possessing oesophageal bulb, prominent genital sucker and posteriorly contiguous vitelline follicles. It is named C. chauhani n.sp. in honour of Dr. B.S. Chauhan, an eminent Zoologist and one of the founder of helminthology in India.

Srivastava (1982) expressed doubt about the validity of C. bhavani as the differences shown by Devraj (1972) from C. indica were not much excepting rows of papilae.Thapar (loc. cit) described C. indica on a single specimen. In view of the non availability of type specimens of these two species it is difficult to decide their status. As such both are

tentatively held valid. With the addition of C. chauhani n.sp. the sub family and generic diagnosis of Caballeroiinae and the genus Caballeroia need to be emended. It is interesting to note that the genus Caballeroia is confined to southern and northern part of the country in its distribution.

Diagaonsis of subfamily Caballerollnae : Paramphistomidae, body elongate, rounded posteriorly, anterior and covered with circular rows of small papillae. Acetabulum ventroterminal, moderately large. Mouth subterminal, oral diverticles large, claviform; oesophageal with or without oesophageal bulb, caeca reaching anteriolateral margin of acetabulum or not. Testes symmetrical or oblique, at times partly overlapping each other, intercaecal, reaching caeca laterally, smooth or crenulated, prequatorial. Cirrus poush elongate, pymform or claviform, contains convoluted vesicula seminalis and cylindrical cirrus, vesicula seminalis externa present. Genital pore bifurcat or just prebifurcat; genital sucker present or not. Ovary small, lateral or median, intercaecal near posterior end. Receptaculum seminis and Laurer's canal present. Vitellaria lateral, follicles restricted between ovarian and testicular zone along the caeca, at times contiguous in postovarian zone. Uterine coils intercaecal. Eggs oval or elongate. Excretory bladder saccular or Y-shaped (?), with anterodorsal pore. Lymphatic ducts present or not. Parasitic in intestine of fresh water fishes.

Type genus : Caballeroia Thapar, 1960

Generic diagnosis of Caballeroia : Same as for the subfamily

Key to species of the genus Caballeroia —

1.	Rows of anterior papillae five; genital sucker; absent	C. indica
	Rows of anterior papillae more than five; genital sucker present	2
2.	Oesophageal bulb absent; vitellaria not contiguous in postovarian zone; caeca long	C. bhavani
	Oesophageal bulb present; vitellaria contiguous in postovarian zone; caeca short	C. chauhani n.sp.

The present specimen in my collection forms the new host and locality record from this region.

Family : Plagiorchiidae Luhe, 1901
emend, Ward, 1917

Sub family : Plagiorchiinae Luhe, 1901
emend. Pratt, 1902

Genus : Astiotrema Looss, 1900

Astiotrema reniferum (Looss, 1898) Stossich, 1904
(Plate XIV, Fig. 1)

One specimen of this trematode parasite was recovered from the intestine of a fresh water fish, Glyptothorax telchitta (Hamilton) collected from Betwa river in the district Jhansi.

On detailed study it was found to bear certain interesting features which are usually not present in the worms of this species. Hence it is redescribed. The differences are considered only intraspecific variations.

DESCRIPTION

Body elongated with rounded extremities, 2.54 x 0.452 mm in size. Cuticle covered with small backwardly directed spines arranged in transverse rows. Spines become progressively denser on anterior surface; spines of each row alternating with preceeding and succeeding rows. Oral sucker terminal, subspherical, 0.14 x 0.15 mm in size. Prepharynx absent,

pharynx large, spherical, 0.1 mm in diameter; esophagus long tubular, 0.28 mm in length, bifurcating into two intestinal caeca reaching short of posterior extremity. Ventral sucker oval, larger than oral sucker, 0.16 - 0.19 mm in size at 0.65 mm or about 1/4th of body length from anterior exremity.

Genital pore submedian, lying infront of ventral sucker at 0.63 mm from anterior extremity.

Excretory pore at hind end of body. Excretory bladder Y-shaped, main stem passes in between two testes in form of a sigmoid curve divided into two short arms between ovary and anterior testis.

Testes entire, oval lying obliquely one behind other in posterior half of body just behind equator. Anterior testis 0.18 x 0.16 mm in size at 1.29 mm from anterior extremity. Posterior testis slightly larger than anterior testis, 0.17 x 0.19 mm in size at 0.724 mm from hind end of body. Cirrus sac claviform, elongated reaching upto ovary, 094 x 0.09 mm in size. Vesicula seminalis large occupies a greater portion of cirrus sac, 0.45 x 0.09 mm in size. Pars prostatica long tubular, 0.14 x 0.02 mm in size, continues forward as an ejaculatory duct, 0.27 mm in length, opening at genital pore. Cirrus muscular and non spiny.

Ovary entire, spherical, preequatorial, 0.08 mm in diameter at 1.1 mm from anterior extremity. Oviduct arises from hind end of ovary opening at ootype. Receptaculum seminis slightly larger than ovary and its left side, 0.085 mm in diameter. Vitellaria small, follicular, mainly lateral covering intestinal caeca extending from hind margin of ventral sucker upto middle region of hind testis. Uterus arises from ootype and runs posteriorly in a sinuous course towards posterior end, passes anteriorly to left of cirrus sac opening at genital pore. Eggs oval, non operculated, 0.0245 - 0.0355 x 0.0112 - 0.0195 mm in size.

Host : Glyptothorax telchitta (Hamilton)

Location : Intestine

Locality : Betwa river, District Jhansi

DISCUSSION

The present form belongs to A. reniferum (Looss, 1898) Stossich, 1904 which has not previously been recorded from a fresh water fish Glyptothorax telchitta (Ham.). The present form differs from other descriptions of A. reniferum in the possession of spines on the body wall, in the absence of prepharynx and in having vesicula seminalis S-shaped. These differences are considered as variations within the species.

The present specimen in my collection forms the new host and locality record from Bundelkhand region.

Family : Heterophyidae Odhner, 1914

Sub family : Haplorchiinae Looss, 1899

Genus : Haplorchoides Chen, 1949

1. Haplorchoides attenuatus (Srivastava, 1935)
   (Syn. Haplorchis silundi Srivastava, 1935;
   Haplorchoides seenghali Gupta, 1953;
   H. macronis Agarwal, 1964;
   Monorchotrema taakree Dayal, 1935;

2. Haplorchoides piscicola Srivastava, 1935;
   (Syn. Haplorchis gangeticum Srivastava 1935;
   Haplorchoides parini Chatterji, 1956;
   H. ritai Gupta, 1953;
   H. brahamputrensis Gupta, 1953;
   H. gomtiensis Gupta, 1953
   H. gomtiensis Gupta, 1953;
   Pseudohaplorchis macrones Dayal, 1949)

On the validity of Haplorchine flukes from Indian siluroid fishes

(Plate XV, Figs. 1-9; Plate XVI, Fig. 10-14)

INTRODUCTION

The small-sized haplorchine flukes, with comparatively feeble suckers, a complex ventro genital sinus and a single testis, occur as intestinal parasites in fishes, birds and

mammals. These have been assigned to a number of genera including Haplorchis Looss, 1899; Monorchotrema Nishigori, 1924; Kasr Khalil 1932; Pseudohaplorchis, Dayal 1949; Haplorchoides Chen, 1949 and Euhaplorchis Martin, 1950. The species from siluroid fishes in Indian region are: Haplorchis attenuatus Srivastava, 1935; H. piscicola Srivastava, 1935; H. gangeticum Srivastava, 1935; and H. silundi Srivastava, 1935 - from Allahabad; Monorchotrema taakree Dayal,1935 and Pseudohaplorchis macrones Dayal 1949 from Lucknow; Haplorchoides gomticusis Gupta, 1953; H. ritai Gupta, 1953; H. brahamputrensis Gupta,1953 and H. seenghali Gupta, 1953, the first two from Lucknow and the last two from Assam; Haplorchis parini Chatterji, 1956 from Allahabad and Haplorchoides macronis Agrawal, 1964 from Lucknow. (P. macrones was excluded by Chatterji (1956) from his comparative table relating to Haplorchis species parasitic in fishes).

There have been conflicting views on the question of the validity of Monorchotrema, Pseudohaplorchis and Haplorchoides. Yamaguti (1954) considered Pseudohaplorchis as a synonym of Haplorchoides (Gupta, 1953) and, retaining both Pseudohaplorchis and Haplorchoides with which Monorchotrema was held to be indentical, included all the above mentioned nine species under Haplorchoides. Chatterji (1956), believing Monorchotrema as identical to Haplorchis, suppressed Haplorchoides as a synonym of Haplorchis in which all the species were included.

Yamaguti (1958), synonymising Monorchotrema and Pseudohaplorchis with Haplorchoides, listed all the species from fishes under it. Agrawal (1964), following Gupta, has retained Pseudohaplorchis and considered Haplorchis distinct from Haplorchoides to which all the species occuring in fish have been assigned by her.

A perusal of the descriptions of these species clearly reveals that the validity of the various species has not been correctly assessed. The prevailing chaos and confusion around Haplorchis and Haplorchoides has, however, been recently cleared by Pearson (1964). From a study of a new species of Haplorchoides, Pearson believed that this genus contains the species occuring in fish. Haplorchoides, characterised by a saccular and post testicular excretory bladder, possesses an armed and modified acetabulum lying obliquely inside the ventrogenital sac. The author follows Pearson (1964) in separating the species parasitic in fishes under Haptorchoides as Pearson's plan conforms fully to this author's conclusions reached from a study of the extensive material collected from the five silaroid fishes. The author fully agrees with the view of Jain (1967) that Chen's conclusion regarding differentiation of the various species of the genus Haplorchis should not be taken into account which is based only on the armature of gonotyle.

Numerous specimens of Mystus seenghala, Eutropiicthys vacha, Mystus vittatus, Wallago attu and Clupisoma garua from Jhansi and Banda were available for examination. The first two fishes invariably revealed a greater incidence. The collection was studied alive, from stained permanent mounts and in sections. The parasite identified as H. piscicola did not appear to be significantly pathogenic.

The ventro-genital complex, correctly emphasized by Pearson as the sole morphological feature, was totally ignored by Srivastava, Gupta, Chatterji and Agrawal who have, on the other hand, relied on the shape of the body, the general topography and position of the organs, the comparative size of the prepharynx and oesophagus, the relative position of the genital pore, the size and extent of the seminal vesicle, and the extent and distribution of the vitellaria - characters showing variations from age and fixation. Besides, the excretory bladder described invariably as Y-shaped, is really saccular and the eggs in some species such as P. macrones have been mentioned as unoperculated. Particulars about the number of the rodlets, except for M. taakree in which 47 spines are given and P. macrones where 35 - 38 spines have been described, are also lacking.

A careful study of the ventro-genital sinus reveals that the embedded accetabulum carries an armature of weakly chitinised fret-saw-shaped rodlets, either 42-48 or 35-40 in

number. Apart from this character, an extreme degree of variability in the characters stressed by Srivastava, Dayal, Gupta, Chatterji and Agrawal in distinguishing their species is observed in the developing and fully mature specimens.

OBSERVATIONS AND DISCUSSION

These small distomes, with spined body-wall, whitish to yellow in colour and with a comparatively more active preacetabular region, were in two distinct forms - elongated or spindle-shaped and with a somewhat ovoid or spherical outline. The body movement, in the fully mature specimens, was less marked. Microscopic examination revealed slight differences in regard to the character and distribution of the vitellaria, the number of rodlets and in the host species.

A. From M. seenghala and W. attu

The elongated or spindle-shaped specimens (Fig. 1, 2 and 3) with a somewhat attenuated anterior region, measured 0.80 - 1.15 mm in length and 0.2 - 0.04 mm in maximum breadth which in the mature specimens, lay in the testicular region. The subterminal oral sucker was 0.038 - 0.064 mm in diameter. The prepharynx measured 0.17 - 0.25 mm in length. The pharynx lying at about the middle of the prebifurcal region measured 0.04 - 0.06 mm x 0.03 - 0.04 mm in size. In the younger specimens and those fixed with the forebody fully extended,

the total length of the prepharynx and oesophagus varied considerably. The genital pore, situated immediately near the intestinal bifurcation, was somewhat laterally displaced lying internally to the caecum (Fig.1), overlapping it or lateral to it (Fig. 3). Through a duct, it communicated upto the ventro-genitel sinus containing the embeded and armed acetabulum. The rounded and thick walled acetabulum carried a circlet of 42 - 48 fret-saw-shaped rodlets (in a single row) (Fig. 4). The terminal excretory pore opened into the sac-shaped excretory bladder which, behind its anterior margin, received the two main collecting canals (Fig. 14). The intestinal caeca, extending behind the middle of the body, terminated a little behind the testis. The testis, lying in the posterior half of the body, was intercaecal, nearly spherical in outline, with smooth margin, and occasionally displaced slightly laterally, measured 0.25 - 0.36 mm x 0.21 - 0.3 mm in size. The bilobed seminal vesicle, lying obliquely and anterolaterally to the ovary, had the anterior and posterior lobes of 0.06 - 0.15 mm x 0.061 - 0.15 mm and 0.032 - 0.15 mm x 0.03 - 0.09 mm size respectively - the size of the lobes depending on the amount of the sperm mass. The seminal vesicle, through a small ejaculatory duct, terminally opened jointly with the metraterm into the ventro-genital complex (Fig. 6). The pretesticular ovary, of rounded shape and with smooth margin, was median in position and, usually lying midway

between the intestinal bifurcation and anterior margin of the testis, measured 0.1 - 0.15 mm in diameter. The nearly rounded receptaculum seminis, of 0.1 - 0.15 mm x 0.1 - 0.16 mm in size was situated lateroposteriorly to the ovary - the Mehlis' gland lying between it and the ovary. The uterus, in its descending and ascending coils, occupied the available spece between the Mehlis' gland and the posterior extremity. The preovarian uterine coils continued into a distinct metraterm which terminally opened, alongwith the ejaculatory duct, into the posterior border of the genital sinus. The vitelline follicles were postovarian, mostly lateral and extended from near the Mehlis' gland complex to a little distance in front of the posterior extremity - a few follicles in the pre and post-testicular areas passing inwards to meet mesially. Eggs were light yellowish in colour, operculated, fully embryonated and 0.024 - 0.03 mm x 0.013 - 0.016 mm in size (Fig. 8).

These specimens, on general characters, totally agreed with H. attenuatus originally described from M. seenghala. This species has been differentiated by its author from the genotype, H. cahirinus, on account of the larger number of spines (H. cahirinus has been reported to possess five spines only) but the number of rodlets in the original account of H. attenuatus has not been indicated. My specimens, taking

into consideration the different variations, were also found to resemble fully such other species as H. silundi from Silundia gangetica; Monorchotrema taakree from Pseudotropius taakree; Haplorchoides seenghali from M. seenghala; and H. macronis from M. seenghala in all of which except for M. taakree, where the number of rodlets has been described as 47, the total numbers have not been given. Accordingly, the description of H. attenuatus has to be emended to incorporate the number of the rodlets and the extreme variations observed by us. All these species are, therefore, suppressed as synonyms of H. attenuatus for which the above account "with 42-48 rodlets" would provide the diagnosis.

B. From E. vacha, M. vittatus and C. garua.

The ovoidal, elliptical or spherical forms measures 0.8 - 2.3 mm in length and 0.30 - 0.58 mm in maximum breadth (Figs 10, 11, 12 and 13). The subterminal oral sucker was 0.06 - 0.1 mm in diameter. The prepharynx was of 0.15 - 0.22 mm in length. The pharynx measured 0.04 - 0.06 mm x 0.03 - 0.04 mm in size. The oesophagus, 0.05 - 0.07 mm in length, showed variation due to fixation. The intestinal caeca extended posteriorly upto the testis. The laterally placed genital pore, lying in the region of the intestinal bifurcation revealed viable positions - lying medially or laterally behind the bifurcation or on level with it. The acetabulum, embedded

inside the ventro genital sinus, carried a circlet of weakly chitinised 35 - 40 fret-saw-shaped rodlets (Fig.5). The median testis was usually spherical and 0.1 - 0.22 mm x 0.1 - 0.19 mm in size. The characteristically bilobed seminal vesicle had the anterior lobe of 0.06 - 0.09 mm x 0.06 - 0.08 mm and the posterior of 0.02 - 0.03 mm x 0.015 - 0.02 mm size. The ejaculatory duct opened, jointly with the metraterm inside the ventro-genital sinus. The prestesticular and rounded ovary was median and measured 0.08 - 0.15 mm x 0.07 - 0.14 mm in size. The Mehlis' gland complex lay between the ovary and the receptaculum seminis which of 0.08 - 0.1 mm x 0.07 - 0.09 mm size, was significantly reduced in some of the specimens or was even absent in several others (Fig.10). The uterus in its descending and ascending coils, occupied the available space between the Mehlis' gland and posterior end of the body. In a number of specimens, some area in the posterior body regions appeared free from eggs. The ascending uterine limb, on its way to the genital sinus, passed into the matraterm (Fig. 7). The vitelline follicles, lying lateral to the gonads, extended from the Mehlis' gland to a little distance behind the intestinal caeca - a few follicles in the post testicular space passing inwards. The eggs were of light yellow colour, operculated, fully embryonated, and measured 0.02 - 0.04 mm x 0.012 - 0.017 mm in size (Fig. 9).

These specimens conformed fully to the description of H. piscicola in which the description is likewise silent regarding the number of rodlets. The number of the rodlets, given for H. macrones, is 35 which can be included within the range encountered by me. The specific description for H. piscicola need be emended toinclude the different variations encountered and "35 - 40 rodlets". H. gangeticum, H.macrones H. parini, H. gomtiensis, H. ritai and H. brahamputrensis are presently suppressed as its synonyms. Haplorchoides is thus represented in our fresh water fishes by only the two species, H. attenuatus and H. piscicola. Future work on life history stages of these and allied systematic units, solely based on adult characters which are not infrequently inadequately described, would provide correct clues for determining their true taxonomic status.

ABSTRACT

From a study of numerous specimens of haplorchine flukes studied from five species of siluroid fishes, obtained from two different localities in Bundelkhand , the twelve species hitherto described under Haplorchis, Monorchotrema , Pseudohaplorchis and Haplorchoides have been found to be based on extremely variable characters. The only criterion of taxonomic importance in addition to the body shape is the armature of rodlets carried by the acetabulum embedded in the

ventro-genital complex. Accordingly, the valid species are Haplorchoides attenuatus (Syn. H. silundi, Monarchotrema taakree, Haplorchoides seenghali, Haplorchoides macronis) and Haplorchoides piscicola (Syn. Pseudohaplorchis macrones, Haplorchis gangeticum, Haplorchoides parini, H. gomtiensis, H. ritai and H. brahamputrensis). A revised description for the two species considered valid has been given and, to the known hosts range, Mystus vittatus, and Clupisoma garua are added.

PART - III

LARVAL TREMATODES

Family : Bucephalidae Poche, 1907

Sub family : Bucephalinae Nicoll, 1914

Genus : Bucephalus Baer, 1827

Bucephalus prasadi n.sp.

(Plate XVII, Fig. 1-3)

During the present investigations, no adult fluke was recovered from fresh water fishes collected from river Betwa in District Jhansi. But two specimens of Eutropiichthys vacha out of a total of 107, and three of Bagarius bagarius out of 126, examined during a period of three years from July 1993 to June , 1996, yielded numerous encysted metacercaria from the mesentary and the body musculature. The intensity of infection varied from 13 to 58 metacercaria per host. Details of morphology including excretory system were traced from the study of living specimens and their stained mounts. With a view to study the invasive capability some of these cysts were fed to clean laboratory reared experimental rats and fishes. On detailed study of excretory system and other morphological characters, metacercariae from both the hosts have been found identical and to belong to a new species, B. prasadi described below. The species is named in honour of Prof. Devendra Prasad of Patna, an eminent helminthologist of India.

DESCRIPTION

Metacercaria

Encysted :- In living state, nearly rounded thin walled cysts have a whitish or cream colour and measure 0.98 - 1.2 mm in diameter. Characteristically folded excretory bladder is visible in the central portion of the cyst. The rhynchus and pharynx are well developed and lie at opposite ends.

In stained mounts the cysts measure 0.88 - 0.96 mm in diameter. The rhynchus measures 0.128 - 0.130 x 0.186 - 0.192 mm in size. Gastric sac nearly encircling the pharynx and the mouth measures 0.104 - 0.108 mm x 0.156 - 0.166 mm in size.

The actively motile and slippery flukes were released after the rupture of the cyst well. The various morphological details are; Body elongated with a broad anterior and slightly narrow posterior end, measures 1.92 - 2.02 mm in length and 0.72 - 1.08 mm in breadth; small cuticular spines are uniformly distributed on whole of the body; circular rhynchus lying anteriorly in subterminal position measures 0.288 - 0.336 mm in diameter; A cluster of 7 - 11 apical glands lies on each side of the rhynchus; seven papilla like tentacular prominences lies just above the rhynchus on anterior end of the body; pharynx, lying a little posterior to body centre, measures 0.12-0.10 mm in diameter; gastric sac lies close to the pharynx.

In a freshly exysted fluke the tubular excretory bladder filled with dark matter and occupying most of the body space below the rhynchus to nearly the posterior end, opens through a sub-terminal excretory opening. The size of the excretory bladder gradually becomes smaller with the passage of time, allowing clear view of excretory details, when the worms are left free in physiological saline or fresh water for some time.

Excretory system

The excretory system consists of a pair of small transverse excretory ducts originating at the level of the bladder. On each side these are joined by a lateral longitudinal duct running anteriorly to rhynchus and posteriorly reaching the body end. Each lateral duct gives off three ductules in anterior region and three in the posterior. Each ductule redivides into two final capillaries ending into a flame cell each. On the basis of this arrangement, the flame cell formula for these specimens, works out to be 2 (2+2+2) + (2+2+2).

DISCUSSION

The genus Bucephalus was created by Baer (1826) for B. polymorphus - a cercaria recovered from a European bivalve mollusc. Since then 58 species have been reported under this

genus from marine and fresh water fishes from U.S.A., Canada Japan, Korea, India, and many European countries. The first report on this genus, from fresh water fishes of India, was made by Verma (1936) who described two new species - B. tridenticularia from Macronius aoria and M. seenghala, and B. aoria from M. aoria. Subsequently Srivastava (1938) added two species namely B. indicus from M. seenghala and B. gangeticus from Paeudotropius athernoides. Srivastava (1963), reported three more species viz. B. bagarious, B. tritentacularis and B. allahabadensis, all from Bagarius bagarius and synonymised B. indicus Srivastava, 1938 with B. tridenticularia Verma, 1936. Later on Kakaji (1969) described another species, B. octatentacularis from Wallago attu. Reviewing Indian Gastrostomes, Srivastava and Chauhan (1973) have analysed the systematic position of Indian species under the family Bucephalidae and have listed nine valid species under the genus Bucephalus.

As stated above, the foundation of this genus was laid down on a cercarial species. But so far, only five cercarial, metacercarial species including B. polymorphus, have been reported from different parts of the world. India is represented by a lone report of Pande and Rai (1964) on a bucephalid metacercaria encysted in B. bagarius without any details of the excretory system. Stunkard (1975) has reviewed the systematic position of these metacercarial species and suggested that of all features, the excretory system with

regard to the position of excretory ducts and their openings is the most reliable taxonomic character. In the light of these facts he has divided all metacercarial species of sub family Bucephalinae in two groups. In the first group the collecting ducts open into the proximal end of the excretory vesicle while in the second the collecting ducts open at the sides of the excretory vesicle. Out of a total of seven metacercarial species in group I, only one B. haemenus Lacaze and Duthiers, 1854 with the flame cell formula 2 (6+6+6) + (3+4+4+3): Matthews (1973), has been referred under the genus Bucephalus. In group II, out of a total of twelve, four species listed are B. polymorphus Baer, 1826; Zeigler (1983) (flame cell formula not known), B. cuculus McCardy (1874) with 2 (2+2+2) + (2+2+2): Hopkins (1954), B. elegans Woodhead, 1930 with 2 (7+7+7) + (8+8+9); Woodhead (1936) and B. cynoscion Hopkins, 1956 with 2 (2+2) + (2+2): Hopkins (1956).

The present material on the basis of the presence of seven tentacular prominences, tubular excretory system and sub terminal excretory pore, can easily be assigned to the genus Bucephalus. On comparison with the known metacercarial species, the present form comes close to B. cuculus McCardy 1874 in having the similar material opening of collecting ducts on the sides of the excretory bladder as also the flame cell formula of 2 (2+2+2) + (2+2+2) given by Hopkins (1956).

But it differs from it in having a well developed transverse duct in a more posterior position and extent of lateral longitudinal ducts. Moreover, the size range of the metacercarial cyst and various organs also differ greatly in the excysted specimen.

In view of these differences the metacercariae are assigned to a new species, Bucephalus prasadi n.sp, named in honour of Prof. Devendra Prasad (Patna), an eminent helminthologist.

EXPERIMENTAL INFECTION

Experimental infection with the metacercarial cyst of B. prasadi n.sp. was tried in the different hosts - a fresh water fish (M. aor) and a mammal (albino rat). The details have been tabulated as under. In both these hosts the infection proved abortive.

TABLE 1 - Experimental details of *B. prasadi* n.sp. infection in *Mystus aor* and Albino rats.

Sl. No.		No.of cysts	Date of infection	Date of autopsy	Age of specimen	No. of specimens recovered
	Mystus aor					
1.		15	15.4.95	22.4.95	-	-
2.		15	15.4.95	29.4.95	-	-
3.		15	15.4.95	6.5.95	-	-
4.		15	15.4.95	13.5.95	-	-
	Albino rat					
1.	M	15	15.4.95	22.4.95	-	-
2.	F	15	15.4.95	29.4.95	-	-
3.	M	15	15.4.95	6.5.95	-	-
4.	F	15	15.4.95	13.5.95	-	-

- - - - - - -

NB - M - Male; F - Female

STRIGEID METACERCARIA

Diplostomulum lalitpurensis n.sp.

(Plate XVIII, Figs. 1 - 4)

Different developmental forms of a diplostomulum metacercaria were collected from the small intestine, body cavity, and body muscles of a fresh water fish, Silonia silondia (Hamilton). Thirteen specimen of this fish were available from the river Betwa in the District Lalitpur (U.P) during the year 1994-95 (mainly). The intestine, on two occassions, yielded numerous immature forms and somewhat more developed specimens, on another occasion, were collected from the body cavity around the heart. The musculature, in two cases, revealed white cysts which, after extraction and subsequent testing, yielded the fully developed forms. These different stages in the present collection were studied alive, subsequently suitably fixed, stained and mounted. Primary excretory system could not be traced. These specimens, on detailed study, were found belonging to a new species. It is designated as Diplostomulum lalitpurensis n.sp. after the name of Lalitpur, the place of collection of fishes.

OBSERVATION

Specimens, collected from intestine and body cavity (Fig. 1), exhibited a finely striated body full of calcareous

corpuscles and with a ventral concavity. Lateral sucking cups and smaller hind-body were only poorly differentiated. Acetabulum, slightly smaller than oral sucker, was located just behind the middle of the body. Genital rudiment and bursa copulatrix could be observed in hind-body with the hold-fast organ in the middle of the posterior half of the body. A pharynx and intestinal caeca were seen only in sections. Different measurements recorded are : length 0.4 - 0.52 mm, width 0.15 - 0.24 mm, oral sucker 0.028 - 0.032 x 0.032 - 0.036 mm, acetabulum 0.024 - 0.028 x 0.28 - 0.032 mm, hold fast organ 0.04 - 0.48 x 0.06 - 0.68 mm.

Cysts (Fig. 2), located mostly in the muscles of the trunk, were whitish in colour and in two parts - the outer fibrous part of host origin measured 1.2 - 1.56 x 0.87 - 0.97 mm, in size and the inner, full of fluid around the contained parsite, was 0.85 - 0.9 x 0.35 - 0.44 mm in dimensions. The juvenile stage exhibited two distinct but nearly equal regions - foliacious fore body with oral sucker, lateral sucking cups, acetabulum and hold fast organ and hind body full of dark calcareous granules of 0.004 - 0.006 mm in size. On teasing the cyst, the parasite performed movements in normal saline and after 4-6 hours the internal anatomy, with essential details of its secondary excretory system, was evident under cover glass pressure (Fig. 3).

The specimens measured 1.19 - 1.28 mm in length and 0.51 - 0.58 mm in breadth, with the forebody of 0.61 - 0.66 mm and the hind body 0.58 - 0.62 mm long. Sub terminal and almost circular oral sucker measured 0.08 x 081 mm in size. Lateral sucking cups were shallow in form and 0.06 x 0.12 mm in size. Pharynx measured 0.036 x 0.056 mm, directly dividing into intestinal caeca. Acetabulum, lying nearly at ¼th of the body length from the anterior end, measured 0.052 x 0.1 mm in size. The nearly spherical hold fast organ, situated just behind the acetabulum and 0.12 x 0.192 mm in size, exhibited a prominent glandular area partcularly in its posterior region. Intestinal caeca were not visible on account of the darker contents of the excretory system and the calcareous granules. Secondary excretory system well developed with a large bladder located in the hind body and connected with a median and two lateral trunks extending anteriorly to near the pharynx and with three transverse commissures, one between the acetabulum and hold fast organ, a second just behind intestinal bifurcation and the third anterior to it in the region of the lateral sucking cups (Fig. 3). The genital rudiments, in the hind body, are represented by four well defined masses, two on each side, consisting of a somewhat rounded anterior and an elongated posterior group - the former representing ovary and Mehlis' gland area and latter the two testes. Bursa copulatrix, at the posterior end of the hind body, received a tubular duct like structure.

Spines, over the body, were absent.

DISCUSSION

Amongst the recognised strigeid larval genera, Diplostomulum Brandes, 1892, Neaseus Hughes, 1927, and Tetracotyle Fillipi, 1859 have been reported from some of our fresh water fishes. A Diplostomum larva was, for the first time, recorded from the fingerlings of Catla catla by Ganpati and Hanumantha Rao (1954). Subsequently, in 1955 they found metacercarial cysts in two other fishes, Labeo calbasu and Nuria danrica from fisheries pond. The other available reports on diplostomula are those of Abraham and Anantaraman (1955) who descfibed black cysts, under the skin, in the fingerlings of C. catla and of Singh R.N. (1955) who gave an account of a new species, D. pigmentata, occurring in black pigmented cysts in muscles of C. catla, Cirrhina mirgala and Labeo rohita. These reports are either based on high mortalities or heavy infestations encountered. Singh, K.S. (1957), evidently not aware of these papers, described another new species, D. elongatus, collected from transparent cysts found loosely attached to the mesentery in Trichogaster fasciatus. Recently Ganpati and Hanumantha Rao (1962), extending their earlier observations to some of the life history stages including metacercaria to adult, have identified the young stages as belonging to Diplostomum ketupanensis Vidyarthi, 1937. Referring to the form described by Abraham

and Anantaraman as identical to the one described by them, these authors have also mentioned that D. pigmentata Singh, 1956 was also similar to it.

The present material on account of its aspinose cuticle, non pigmented character of its cysts, nearly equal size of the fore-and hind-body and absence of an oesophagus appears distinct from the metacercarial forms studied by Ganpati and Hanumantha Rao, Abraham and Anantaraman, and Singh R.N. This form, from the body cavity around heart. Silonia silondia (Hamilton) is, therefore, assigned tentatively to a new species of Diplostomulum, D. lalitpurensis n.sp. It can easily be distinguished from D. elongatus Singh, 1957 which, inside transparent cysts, occurs loosely attached to the mesentery, is much smaller in size and lacks entirely the calcareous granules. The forms, recovered from intestine and body cavity, were distinctly younger in development and apparently represented the stage prior to its entry into the musculature where the characteristic metacercarial cysts subsequently develop. Question of validity of the various diplostomulae and the allied larval forms in strigeids can best be settled after work on the life cycle studies has been conducted and the adult forms, developing from them, are available for comparison.

Host : Silonia silondia (Hamilton)
Location : Small intestine, Body cavity, Body muscles.
Locality : Betwa river, District Lalipur (U.P).

Family : Strigeidae Railliet, 1919

Sub family : Strigeinae Railliet, 1919

Prohemistomulum umapatii n.sp.

(Plate XIX, Figs, 1-3)

Out of 23 fresh water fishes, belonging to species Badis badis (Hamilton), catched from river Ken in district Banda (U.P), only one fish was found infected with a metacercarial cyst. The cysts were attached with the body muscles. On detailed examination it appeared to be a strigeid belonging to larval genus Prohemistomulum Ciurea, 1933. It is designated as Prohemistomulum umapatii n.sp. in honour of Prof. Umapati Sahai of Unversity of Ranchi (Bihar), an prominent helmintholist and is described herewith.

Cyst (Fig. 1) is rounded, double layered, thin, and measures 0.40 - 0.50 mm in diameter. It breaks easily under the pressure of coverslip.

Body (Fig. 2) is oval, spinose, with rounded ends, measuring 0.26 - 0.30 x 0.12 - 0.15 mm. Oral sucker is terminal and measures 0.06 - 0.08 x 0.06 - 0.07 mm. Ventral sucker is circular, smaller than oral sucker, located behind

the middle of the body and measures 0.01 - 0.02 mm in diameter. Hold fast organ is almost circular in outline and measures 0.08 - 0.09 x 0.05 - 0.06 mm. Hold fast gland is present at the postero lateral margin of the hold fast organ. Prepharynx is indistict. Pharynx is wide, elongated and measures 0.03 - 0.04 x 0.04 - 0.05 mm. It leads into 0.03 - 0.04 mm long, tubular, oesophagus. Intestinal caeca are symmetrical, terminating in the hind body region. Gonads are well developed and represented by three dark stained masses of cells, linearly arranged along with the lateral margins of hold fast organ. Anterior mass represents the ovary while the other two masses represent the testes.

Excretory bladder is (Fig. 3) 'V' shaped and opens out terminally through an excretory pore. The reserve excretory system consists of two main collecting canals one on each side of the body. They unite anteriorly by a transverse canal. A short median canal arises from the transverse canal and divides into two lateral canals which open into the main canals in the acetabular region. The whole arrangement of canals appears as W-shaped. A number of small, round excretory corpuscles move freely inside the excretory canals.

Since the present metacercaria has (1)-Body round to oval, flat, not separated into two parts, (2)-No lateral

pseudo-suckers and (3) A reserve excretory system consisting of three main vessels united to form 'W' shaped pattern containing free moving excretory corpuscles, it is, therefore placed under the larval strigeid group Prohemistomulum Ciurea, 1933. It shows resemblence with the following metacercariae viz, Metacercaria of C. orientails Faust, 1922; Prohemistomulum circulare Ciurea, 1933; C. melanittae Yamaguti, 1934; Metacercaria of C. nravieri Mathias, 1935; Metacercaria of Prohemistomulum chandleri Vernberg, 1952; Metacercaria of C. bushiensis Khan, 1962; Prohemistomulum metacercaria Rai and Pande, 1969 and Metacercaria of C. bithyniae Sudarikov, 1964. The present larva chiefly differs from all the above species in the shape and arrangement of genital rudiments.

Host	Badis badis (Hamilton)
Location	Body muscles
Locality	River Ken, District Banda (U.P).

- - - - - -

Family : Isoparorchiidae

Genus : Isoparorchis Southwell, 1913

Metacercaria of Isoparorchis hypselobagri (Billet, 1898) Odher, 1927

(Plate XX , Fig. 1)

Out of about seventy eight specimens of Mystus vittatus (Bloch) examined during the present investigation during 1994-96, only six were found infected with metacerearíae of a fluke which, on study, revealed to be the metacercariae of Isoparorchis hypselobagri (Billet, 1898) Odhner, 1927. The fishes were mostly obtained from the fish market at Jhansi but thirty seven specimens were collected with the help of fishermen from river 'Betwa'. The latter were found infected with the metacercaria in question. Besides, Mystus vittatus, other fishes viz., Punitius ticto (Hamilton), Puntius sophore (Hamilton), Labeo calbasu (Hamilton), Rita rita (Hamilton), Xenentodon cancila (Hamilton) and Oxygaster bacaila (Hamilton) were also examined for the metacercaria and one specimen of Oxygaster bacaila (Hamilton) obtained from the river 'Betwa' at District Jhansi was found harbouring only seven specimens of this metacercaria.

The metacercaria is described here in detail.

DESCRIPTION

Habitat : The metacercariae, varying from the one to five in number, were obtained from the body cavities of the hosts. They were found not encysted on visceral organs but in free state, and they appeared golden yellow or brown in colour. When taken out in saline from the body cavities of its hosts, it showed active movements of expansions and contractions of its body. The preacetabular portion of body was extremely mobile.

Morphology : Body aspinose, thick and elongated, anterior end being more attenuated than posterior end. It measures 1.63 - 3.80 mm in length and 0.37 - 1.42 mm in maximum breadth at the equatorial region. Suckers well developed and circular in outline. Oral sucker subterminal and measures 0.09 - 0.36 mm x 0.12 - 0.31 mm. Ventral sucker much larger than oral sucker, pre-equatorial, situated at a distance of 0.21 - 1.24 mm from the anterior end of body and measures 0.15 - 0.60 mm x 0.16 - 0.63 mm. A preparynx is absent. Pharynx well developed and measures 0.04 - 0.15 mm x 0.05 - 0.28 mm. Oesophagus extremely short but easily seen in live specimens. It measures 0.03 - 0.15 mm in length. Intestial caeca broad and appear yellow or brown with the contained food matters.

They run in a sinuous course upto posterior end of body. In the living condition, intestinal caeca have been observed undergoing, at random, contractions and thereby ejecting the contents through mouth.

Gonads as yet, poorly developed. Testes appear as two small oval or round bodies located at the sides of ventral sucker in the intercaecal field. Right testis measures 0.01 - 0.07 mm x 0.01 - 0.09 mm. Left testis slightly larger than right testis and measures 0.01 - 0.10 mm x 0.01 - 0.07 mm. Vasa efferentia arising from testes run forward and eventually unite, in front of ventral sucker, to form a short was deference which is continued into a narrow vesicula seminalis lying free in the body parenchyma. Vesicula seminalis is continued into a short ejaculatory duct enclosed in the so-called 'sinus sac' of Manter (1936). Genital pore median and located behind the intestinal bifurcation.

Ovary is present on the right side in the form of a transversly elongated structure in the hind region of body in front of the excretory bladder. A small pear shaped receptaculum seminis is present. A Laurer's canal is present. Vitellaria are in the incipient stage of development and are represented by dark staining cells in front of the excretory bladder.

Southwell (1913) described the excretory vesicle as club shaped. His account, however, lacks details of the excretory system. Chauhan (1953), while giving the generic diagnosis of Isoparorchis, mentioned the excretory bladder to be Y-shaped. Yamaguti (1958) in the treatise 'Systema helminthum' appears to have followed Chauhan (1953) while giving the diagnostic feature of the genus Isoparorchis as he, too, states 'excretory bladder Y-shaped'. The writer finds the excretory bladder to be a cylindrical structure in this fluke. The club shaped excretory bladder described by Southwell (1913) is attributable, in the opinion of the writer, to the contraction of the body which usually happens during fixation.

DISCUSSION

The occurrence of the metacercariae of Isoparorchis hypselobagri has been recorded in India by Southwell and Prashad (1918), Bhalerao (1926, 1936), Chauhan (1947), Jaiswal (1957), Bhardwaj (1961), and Rai and Pande (1965) from various fresh water fishes viz., Barbus tor, Ophiocephalus striatus, Notopteus notopterus, Ophiocephalus marulius, Ophiocephalus gachua, Mastacembalus armatus, Ambasis nana, Wallagonta attu Gobius giuris, Clarias batrachus, Callichrous bimmaculatus, Belone cancila, Mystus seenghala, Mystus vittatus and Eutropiichthys vacha.

The adult fluke, I. hypselobagri, is a common parasite of Wallago attu which being a predator, preys upon small varieties of fishes, the latter, when infected, possibly serve as transport hosts. Bhalerao (1932) reported immature forms of Isoparorchis sp. from a crocodile and Simha (1958) from a turtle in India. These reptiles do not appear to be the natural definitive hosts, most probably they contracted the infection accidentally by preying upon fishes infested with the metacercariae of Isoparorchis sp. Regarding the records of the occurrence of the metacercariae of I. hypselobagri from foreign lands, Yamaguti (1934) reported his finding of the metacercariae of this fluke from several fishes in Japan. The present find of the occurrence of the metaceracariae of I. hypselobagri on Mystus vittatus adds one more fish to the list of hosts recorded from India.

Host	Mystus vittatus (Bloch)
Location	Body cavity
Locality	River Betwa , District Jhansi.

It is a new host and locality record from this region.

EXPLANATION OF PLATES AND FIGURES

EXPLANATION OF PLATES AND FIGURES

PLATE I — *Neopodocotyle betwai* n.sp.

Fig. 1 Mature worm (Entire), ventral view.

Fig. 2 Oesophagus and cirrus pouch (enlarged)

Fig. 3 Cirrus pouch (enlarged).

PLATE II — *Neopodocotyle jhansiensis* n.sp.

Fig. 1 Mature entire worm (Ventral view)

PLATE III

Fig. 1 *Asymphylodora puntiusi* n.sp.
Adult mature worm (entire), Ventral view.

Fig. 2 *Phyllodistomum hardayali* n.sp.
Adult mature worm (entire). Ventral view.

PLATE IV — *Phylodistomum phulanei* n.sp.

Fig. 1 Adult mature worm (entire), Ventral view.

PLATE V — *Phylodistomum tripathi* Motwani & Srivastava, 1961

Fig. 1 Adult mature worm (entire), Ventral view.

Fig.2-3 Showing different positions of testes.

Fig. 4 Showing different course of intestinal caeca

PLATE VI — Gorgotrema barbius Dayal, 1938

Fig. 1 Adult mature worm (entire), Ventral view.

Fig. 2 Ovary and ootype complex (enlarged).

Fig. 3 Vesicula seminalis and metraterm (enlarged).

PLATE VII — Bucephalus bundelkhandi n.sp.

Fig. 1 Adult mature work (entire), Ventral view

Fig. 2 Rhynchus with four tentacles at oral end.

PLATE VIII

Fig. 1 Bucephalopsis bundeli n.sp.
Adult worm (ventral view)

Fig. 2 Bucephalopsis ramalingami n.sp.
Adult mature worm (ventral view).

PLATE IX — Bucephalopsis garuai Verma, 1936

Fig.1-3 Adult mature worm (Ventral view)

Fig. 4 Showing the pharynx between the two testes

Fig. 5 Showing the vitelline follicles in anterior

Fig. 6 Showing the ovary anterior to intestine.

PLATE X — Neobucephalopsis chauhani n.sp.

Fig. 1 Adult mature worm (entire). Ventral view.

PLATE XI — Genarchopsis jaini n.sp.

Fig. 1 Adult mature worm (entire). Ventral view.

Fig. 2 Showing two large compact or lobed massed of vitellaria lying very closely in the posterior region of body (Dorsal view).

Fig. 3 Showing two vitellaria masses forming a symmetry with two testes and an ovary (Dorsal view).

Fig. 4 Showing two testes smaller than the ovary (Dorsal view).

Fig. 5 Eggs with filaments.

PLATE XII — Genorchopsis goppo (Tubangui) Ozaki, 1925

Fig. 1 Mature adult worm. Ventral view.

PLATE XIII — Caballeroia chauhani n.sp.

Fig. 1 Adult mature worm (Ventral view).

PLATE XIV — Astiotrema reniferum (Looss, 1898) Stossich, 1904

Fig. 1 Adult mature worm (entire). Ventral view.

PLATE XV — Haplorchinae flukes

Fig.1-3 Showing the spindle shaped mature worms, Haplorchis attenuatus, Srivastava, 1935.

Fig. 4 Showing the acetabulum in H. attenuatus with circlet of 42 - 48 fret-saw-shaped rodlets (in single row).

Fig. 5 Showing the acetabulum in H. piscicola with weak chitinised 35 - 40 fee-saw-shaped rodlets

Fig. 6 Showing in H. attenuatus the seminal vesicle through a small ejaculatory duct, terminally opened jointly with metraterm into the ventro-genital complex.

Fig. 7 Showing in H. piscicola, the ascending uterine limb continued into distinct metraterm which opens terminally alongwith the ejaculatory duct into the posterior border of the genital sinus (genital atrium)

Fig. 8 The operculated and fully embryonated egg of H. attenuatus

Fig. 9 The operculated and fully embryonated egg of H. piscicola.

PLATE XVI Haplorchinae flukes

Fig.1-3 The mature worms, Haplorchis piscicola Srivastava, 1935 of different shapes and sizes.

Fig. 4 The mature worm, H. attenuatus, showing the terminal excretory pore opening into the sac-shaped excretory bladder.

PLATE XVII — Bucephalus prasadi n.sp.

Fig. 1 Metacercarial cyst in living state.

Fig. 2 Freshly excysted larva

Fig. 3 Excysted larva after three hours showing the excretory system (The excretory ducts and flame cells are shown much enlarged and not proportionate to the scale given for this figure).

PLATE XVIII — Diplostomulum lalitpurensis n.sp.

Fig. 1 Developing displostomulum. Entire mount showing two suckers, hold-fast organ, genital rudiment and region of bursa-copulatrix.

Fig. 2 Metacercarial cyst showing the outer and inner walls with the harboured stage.

Fig. 3 A metacercaria removed from the cyst and showing oral sucker, pharynx, intestinal caeca lateral sucking cups, acetabulum, hold-fast organ and secondary excretory system.

Fig. 4 Permanent stained mount showing oral sucker, pharynx, intestinal bifurcation, acetabulum, hold-fast organ, lateral sucking cups in the fore-body and genital rudiments with bursa copulatrix in the hind body.

PLATE XIX — *Prohemistomulum umapatii* n.sp.

Fig. 1 Metacercarial cyst

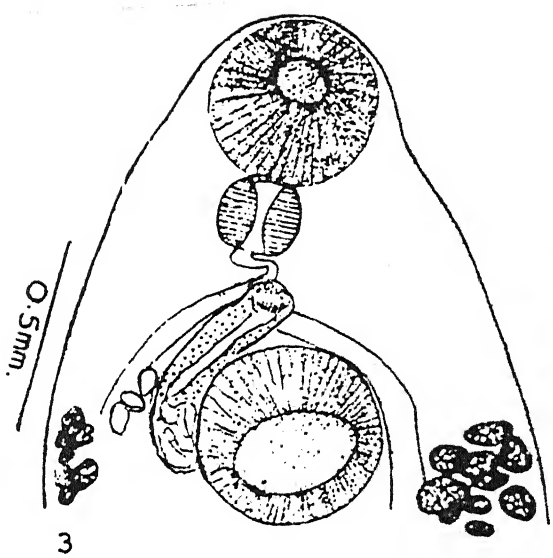
Fig. 2 Excysted metacercaria

Fig. 3 Excretory system in the metacercaria.

PLATE XX — Metacercaria of *Isoparorchis hypseobagri* (Billet, 1898)

Fig. 1 Ventral view of metacercaria (a mounted specimen).

PLATE I



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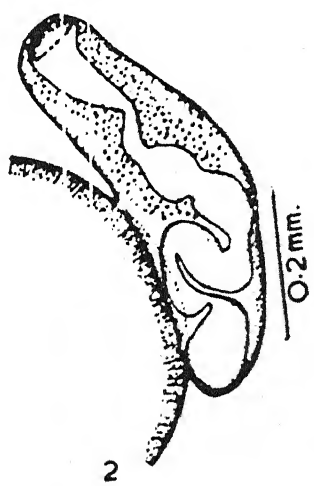

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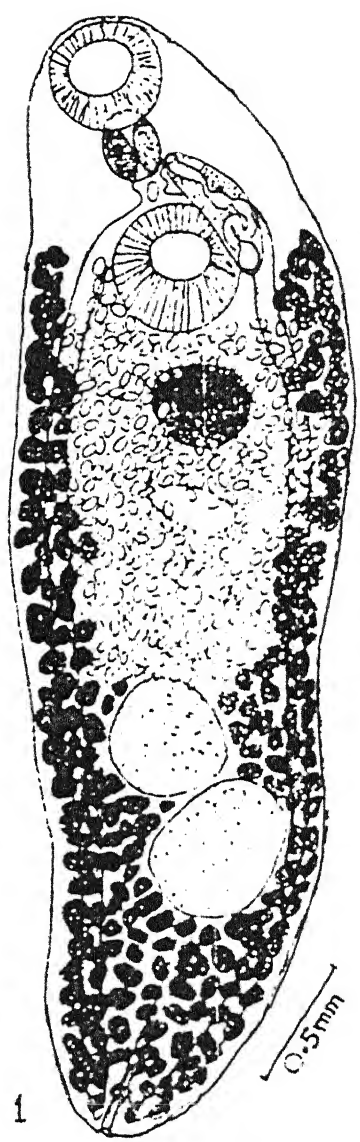

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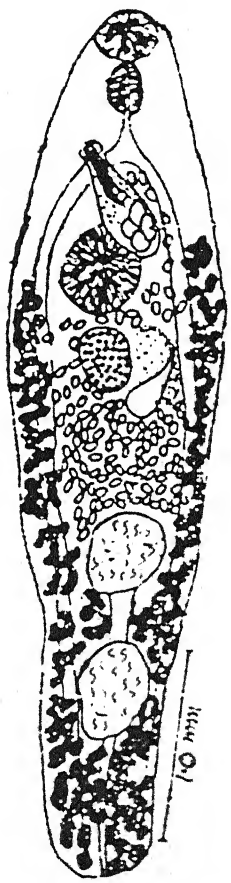

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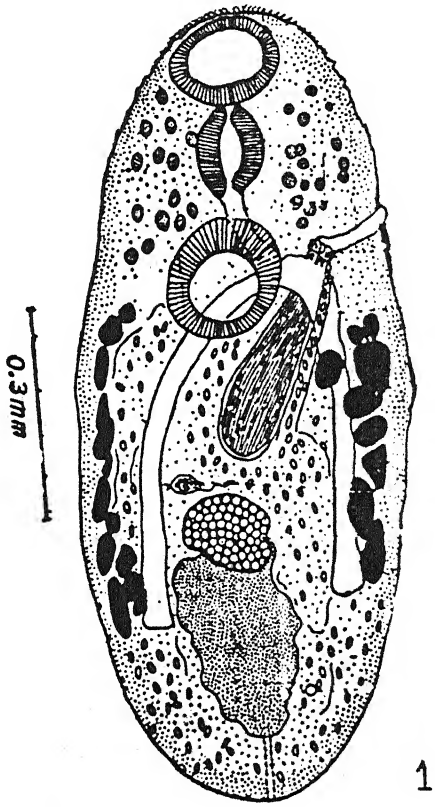

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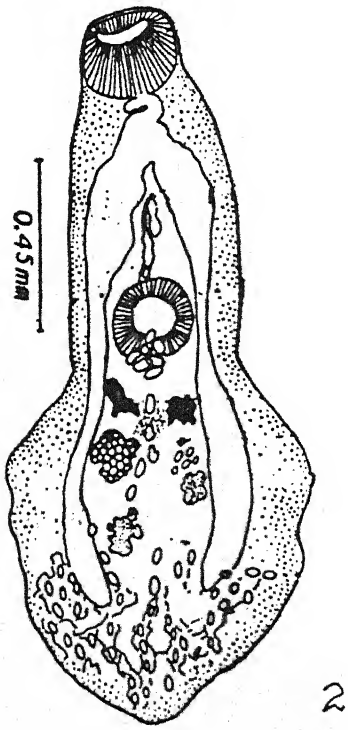

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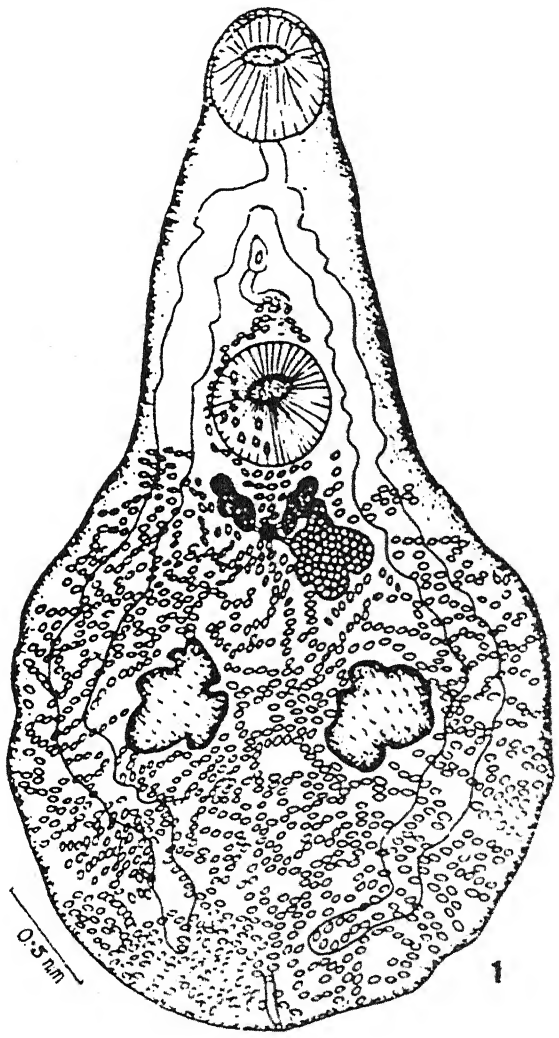

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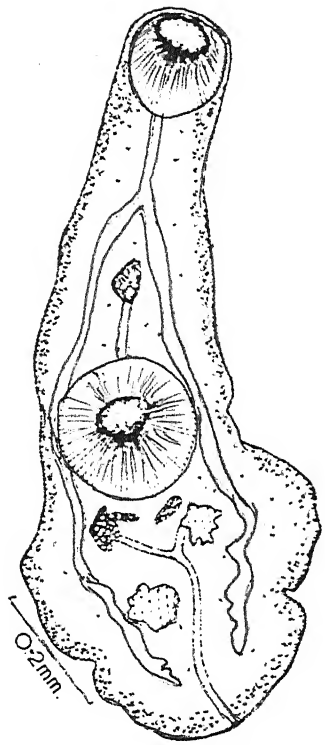

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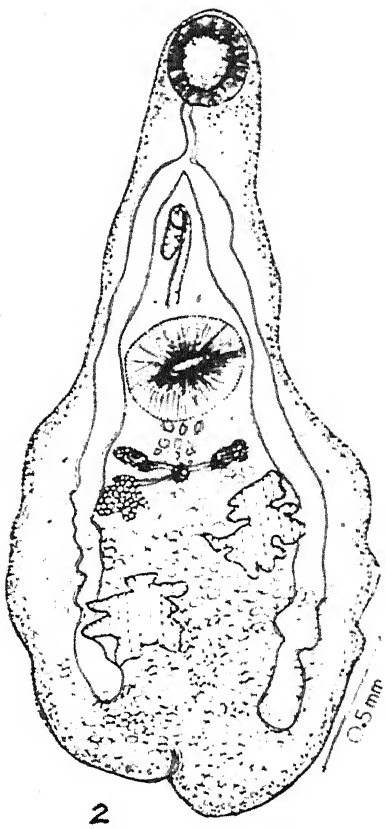

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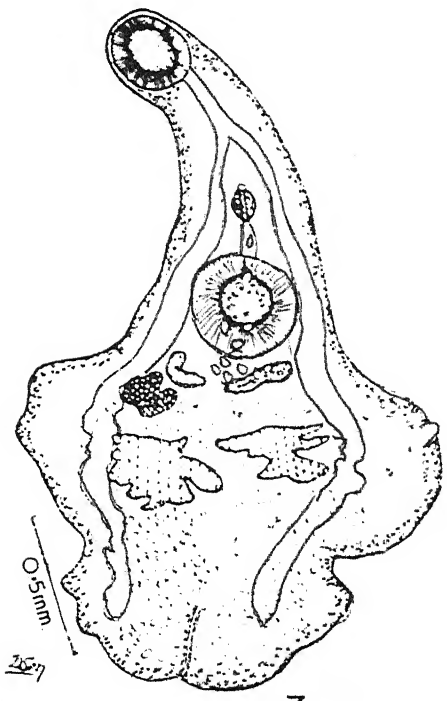

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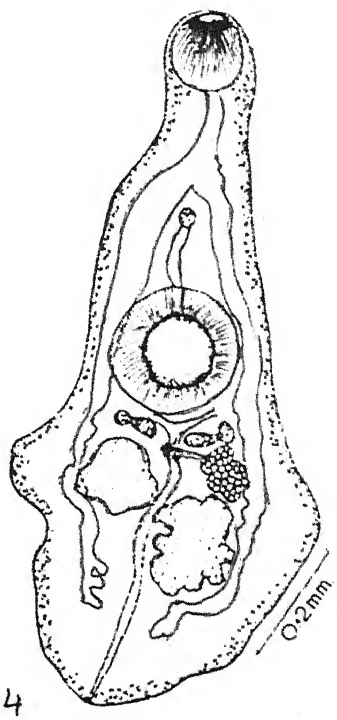

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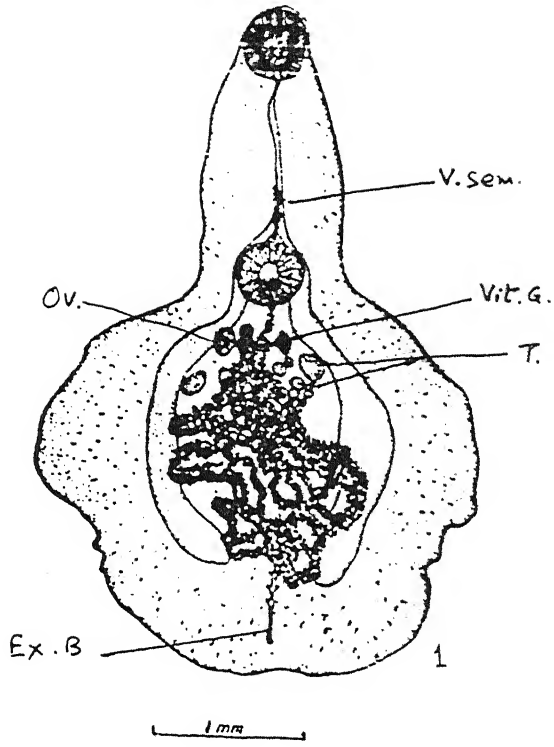
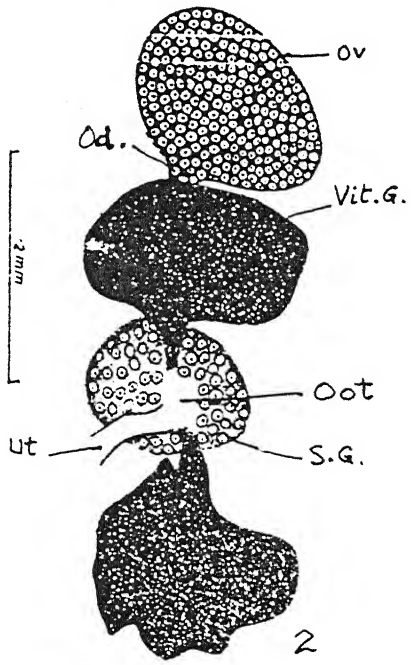
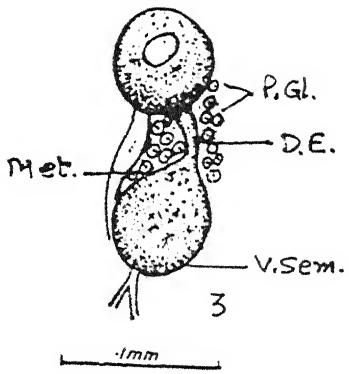
PLATE VI

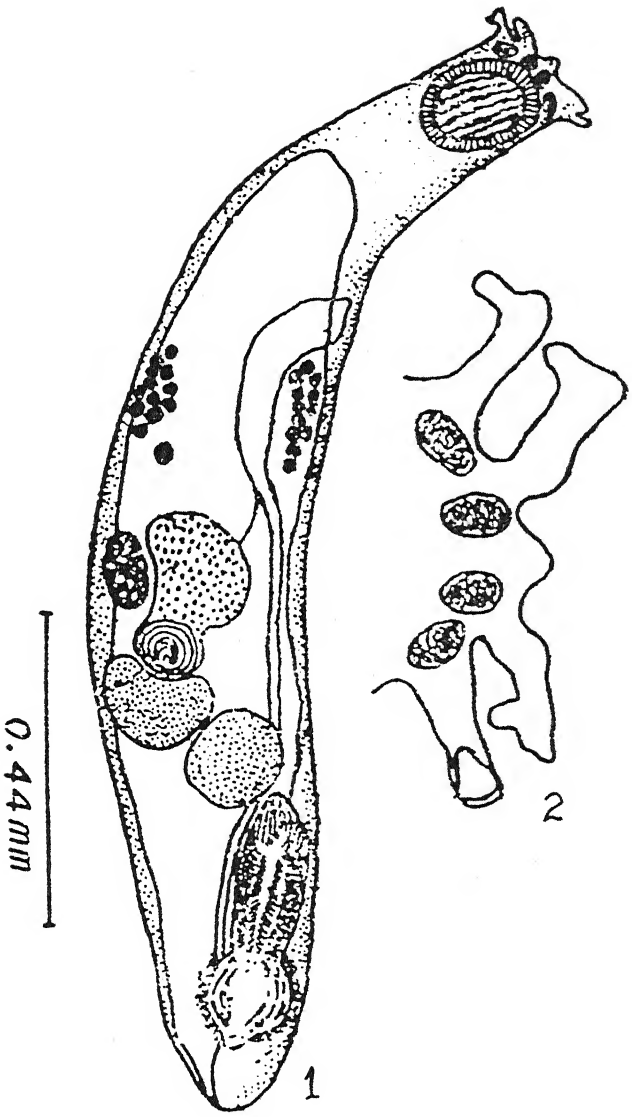






Ex.B. Excretory bladder ; Met. Metraterm ; Od. Oviduct ; Oot. Ootype ; Ov. Ovary ; P.Gl. Prostate Glands ; S.G. Shell Glands ; T. Testes ; Ut. Uterus ; Vit.G. Vitelline Glands ; V. Sem. Vesicula seminalis.

PLATE VII



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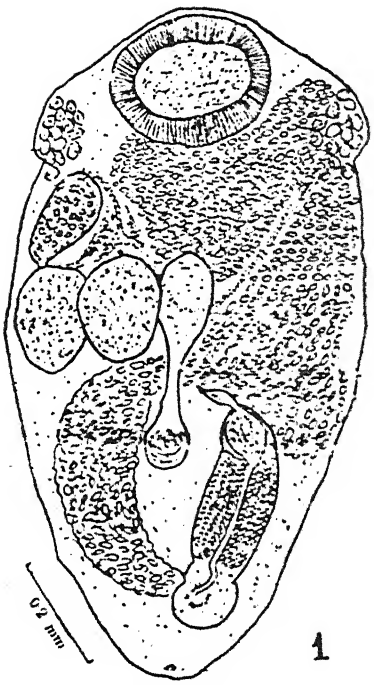

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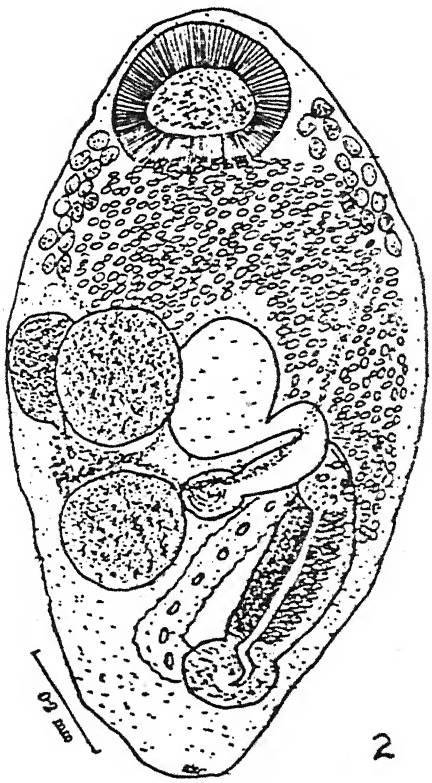

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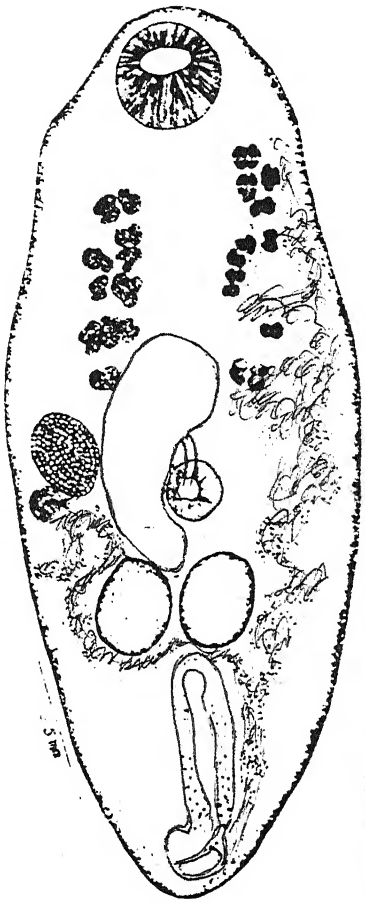

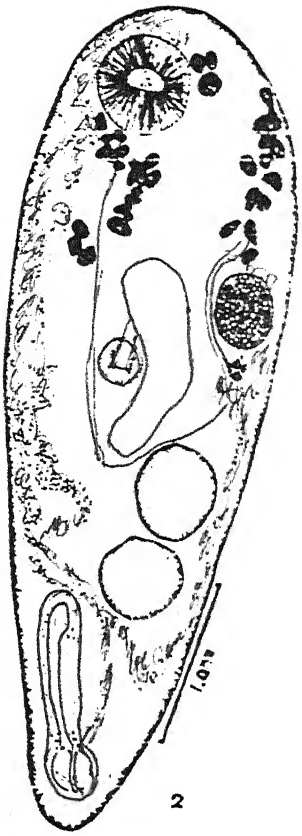

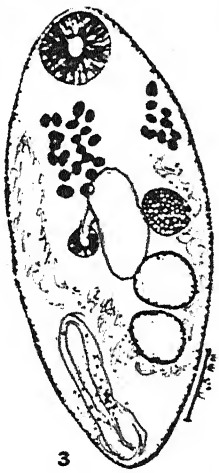

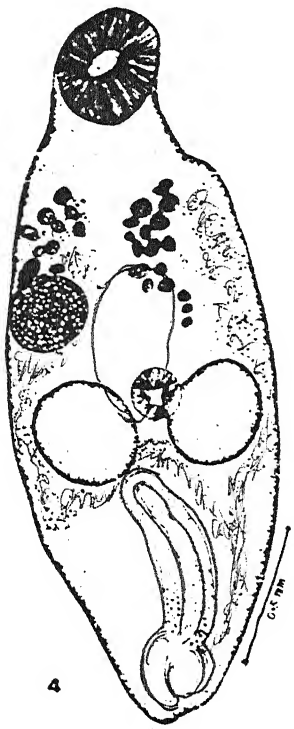

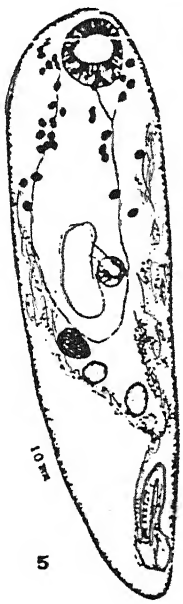

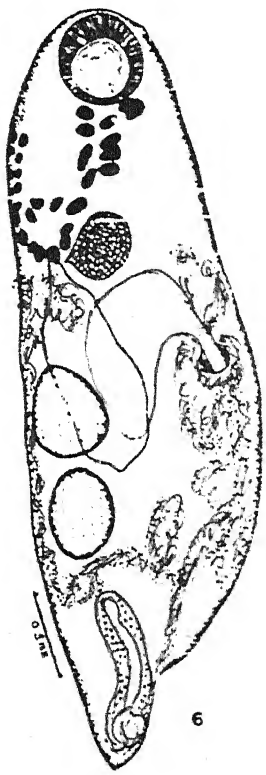

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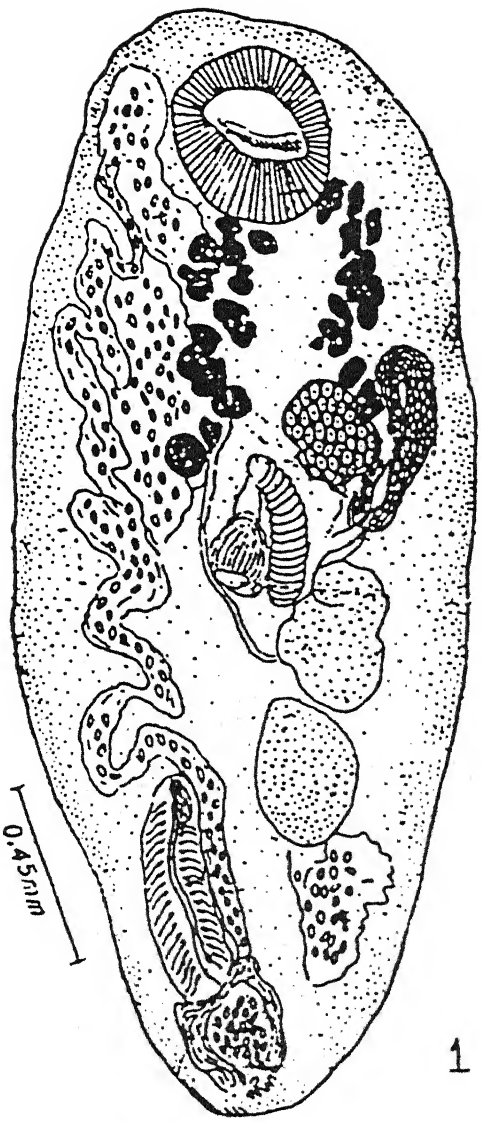

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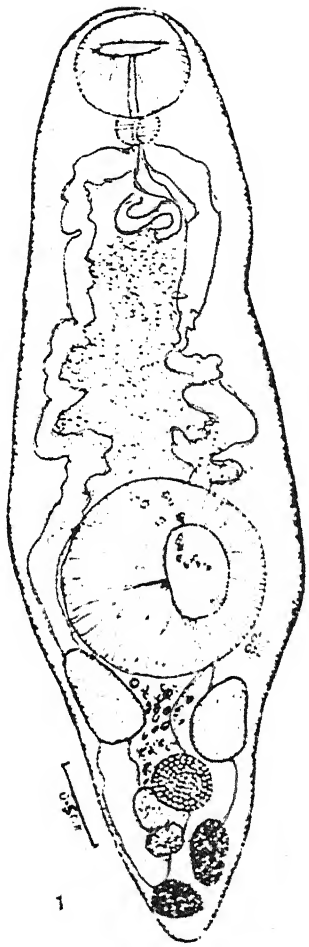

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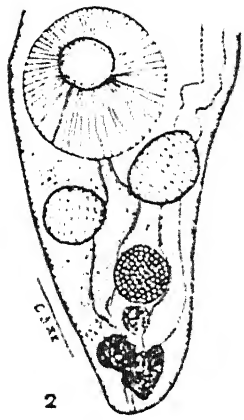

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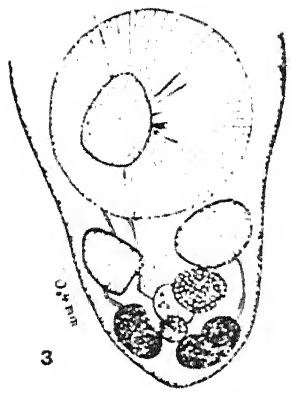

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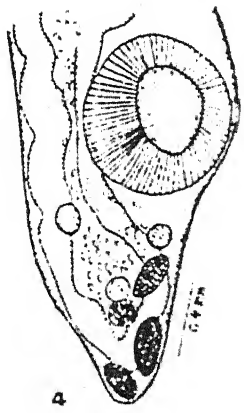

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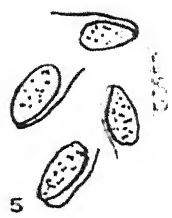

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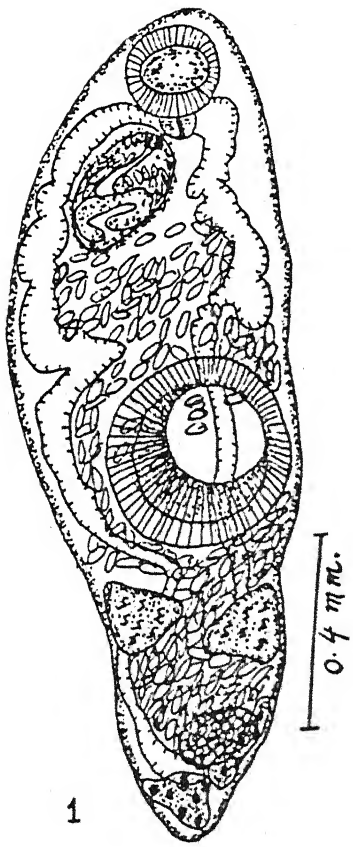

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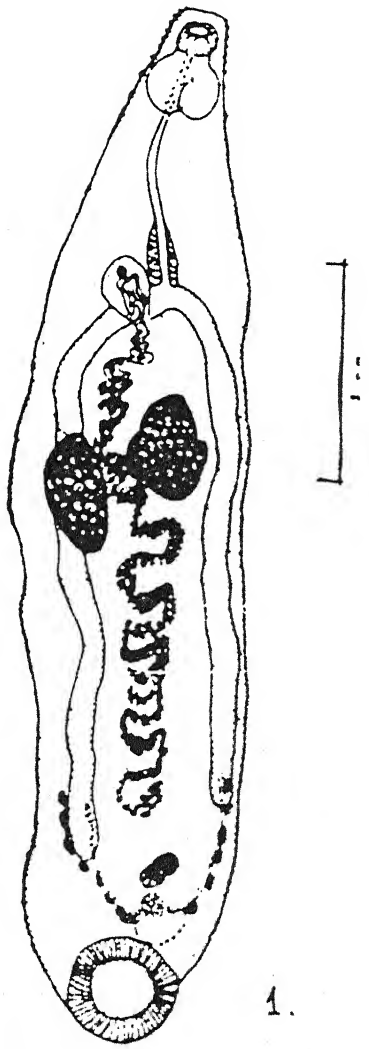

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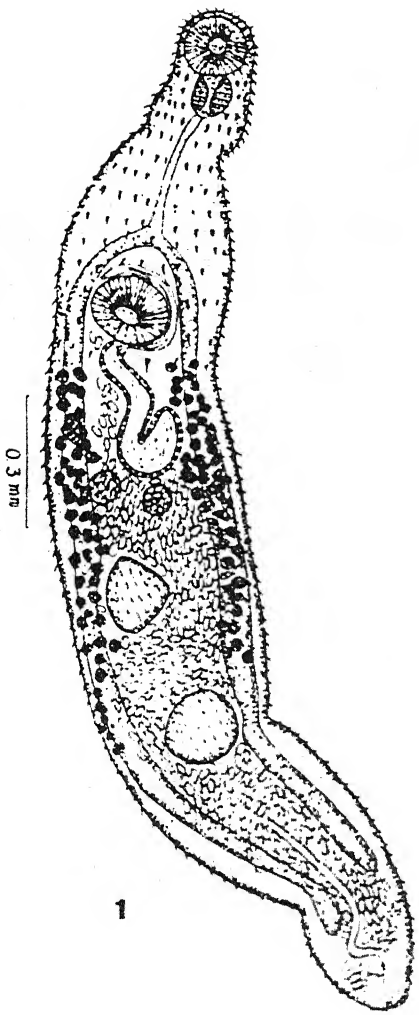
PLATE XIV



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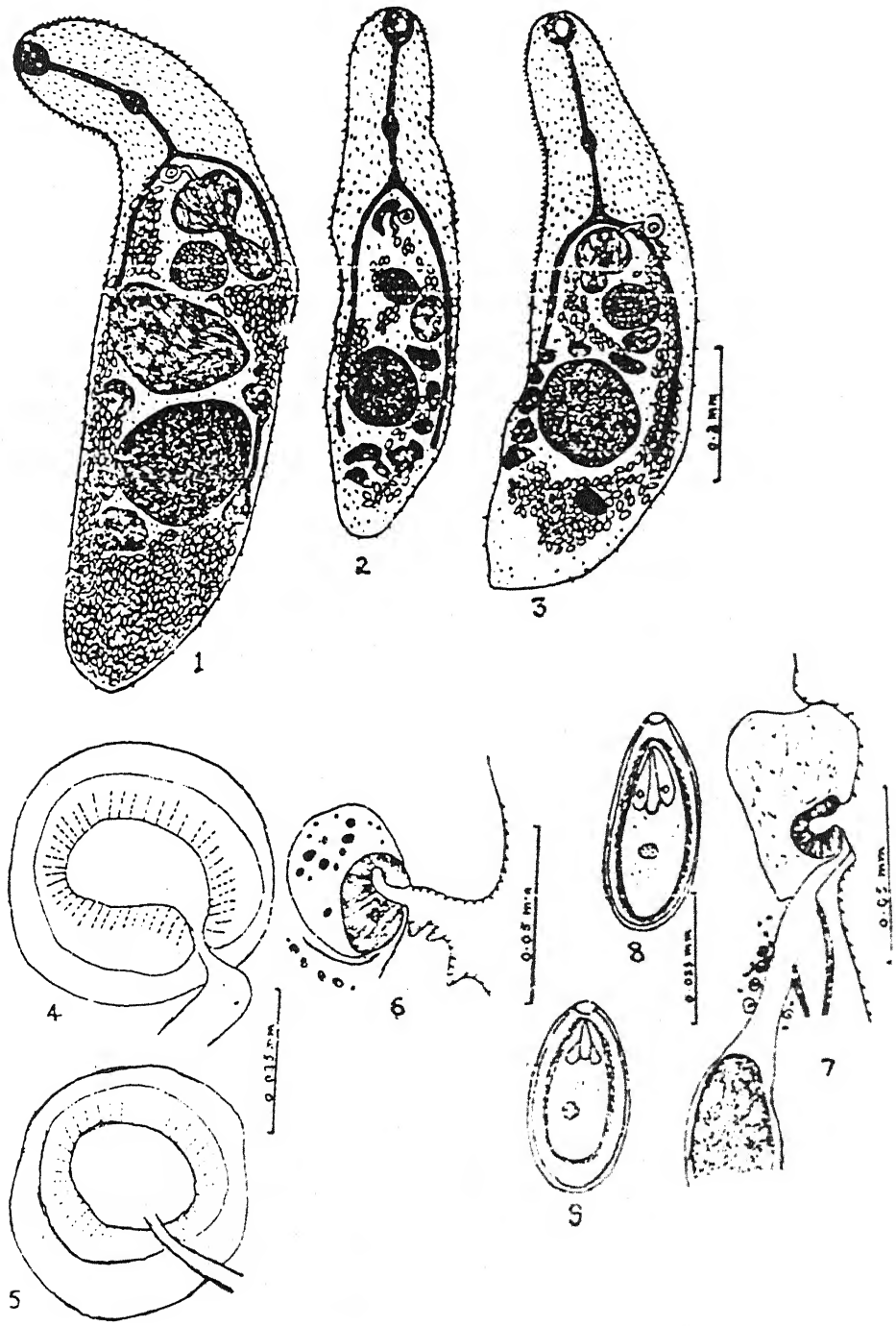

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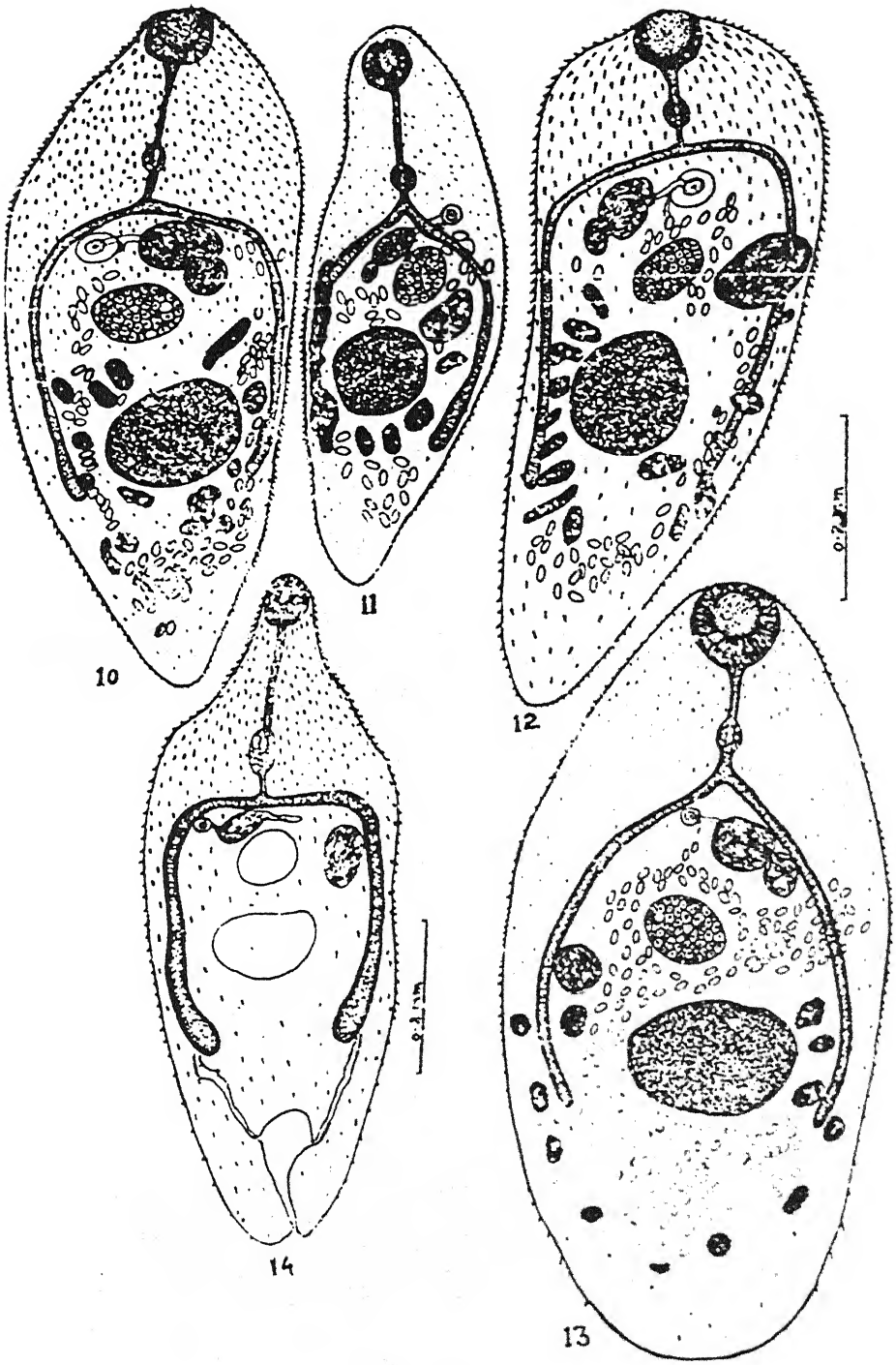

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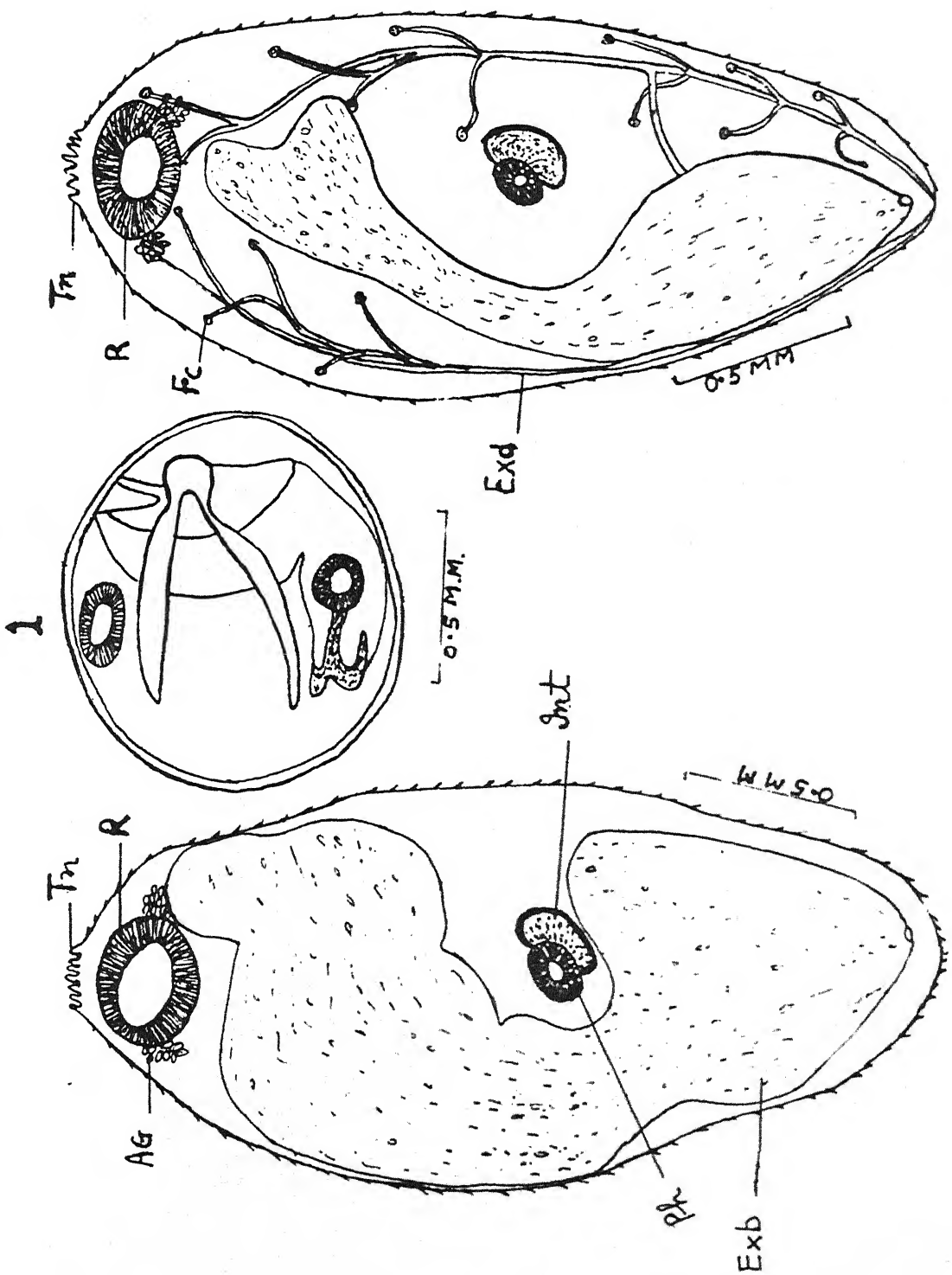

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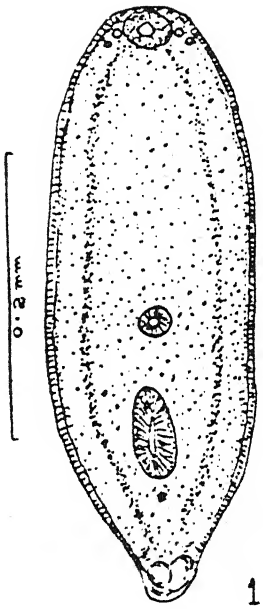

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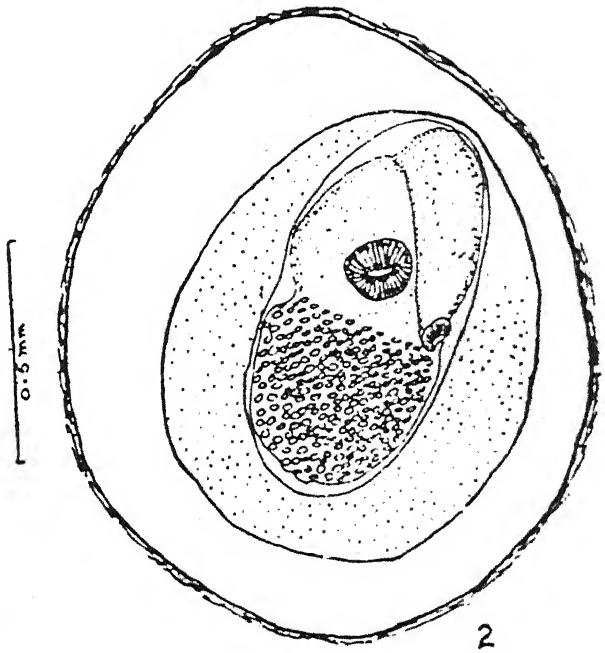

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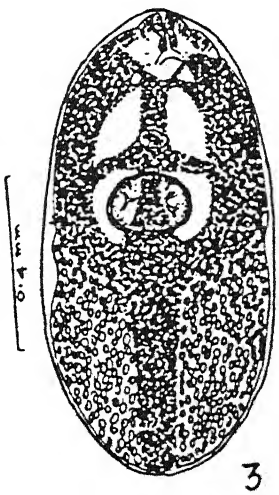

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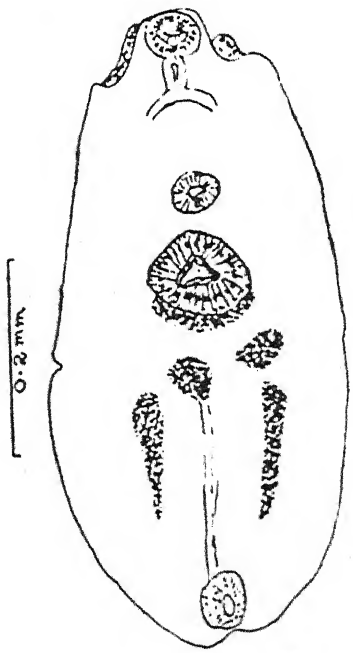

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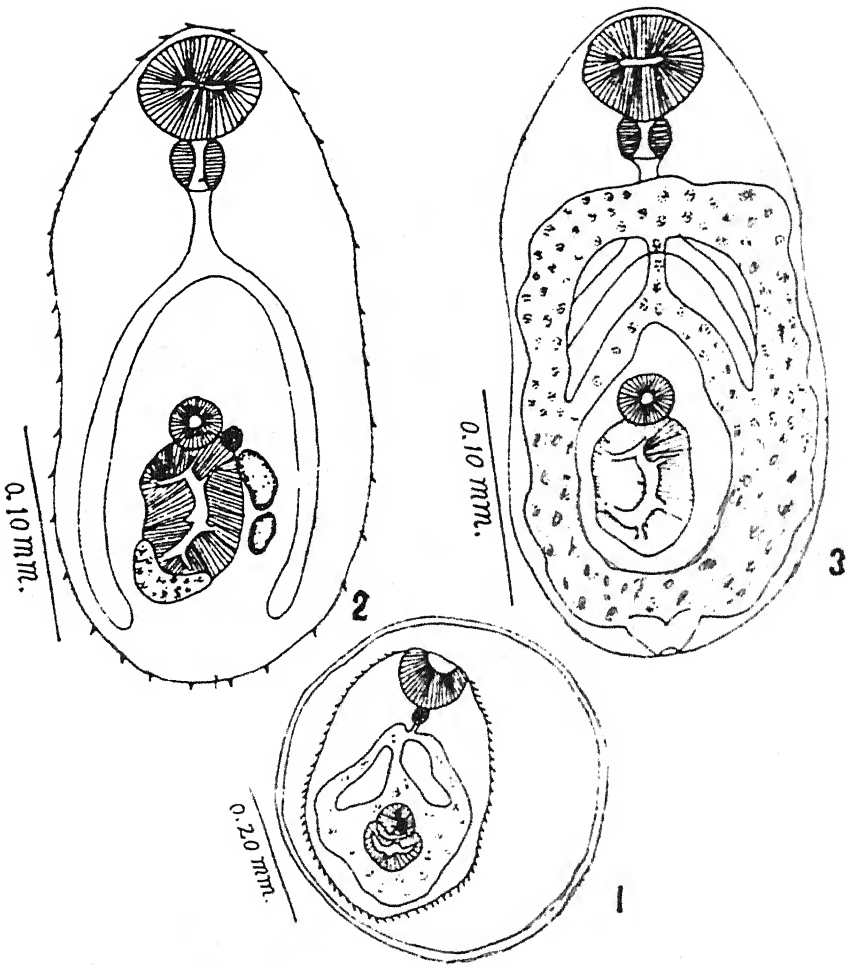

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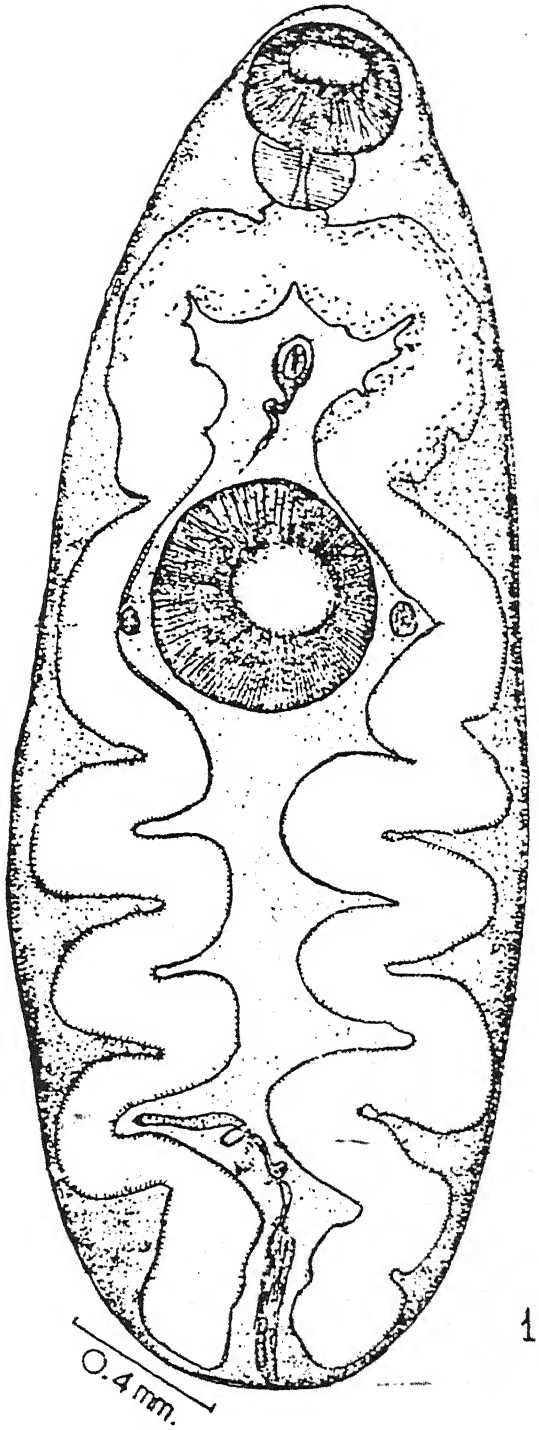

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SUMMARY

Due to compelling economic reasons the fish farming is developing fast into a major profitable industry. In India over 7.5 million people depend on fish and fishery for their livelihood, while 23,000 are engaged in ancillary vocations such as basket and ice making, fish processing and transport etc. The fish fauna, constituting one of most economic groups, provides proteins, many medicinal and industrial oils, vitamins, insulin, enzymes etc.

Fish like other animals are prone to a number of diseases which are responsible for heavy losses due to mortality and morbidity. The helminthic parasites cause various parasitic diseases in fishes. The trematode parasites are mainly responsible for such diseases in the fishes. Fish born zoonsis is more significant specially in case of trematode parasites.

With this background in mind, the present study was undertaken. The observations embodied in the thesis are based on the study of material gathered from extensive survey of digenetic trematode parasites only from Betwa and Ken rivers passing through the Bundelkhand region.

This study has brough certain facts to our knowledge, such as the fishes fauna usually found in these two rivers,

the digenetic trematode parasite which are found in them, and the intensity of infection in these fish hosts.

The fishes were collected regularly from only these two rivers, the dams made on them, and from the local markets in the cities where supply of fishes is generally from these rivers for a period of three years, from July 1993 to June, 1996.

A total of about 1875 fishes were examined from these two rivers of the Bundelkhand region. A thorough search was done to collect the parasites from various organs of the fishes.

Soon after collection the trematodes were studied alive to observe spines or papillae if any, excretory system and genital opening. For preparing whole mount of trematodes the worms were relaxed in fresh water for some time. The body was gently stretched by adding buke warm water. Specimens were kept in 5 - 10 % formaline overnight to fix, then washed with water. The worms were dehydrated by passing in the series of alcohol, stained in borax carmine or acetoalum carmine, cleared in xylene or clove oil, and finally mounted in DPX or Canada balsum.

The diagrams were prepared with the help of a camera lucida in a proper magnification.

The work incorporated in the present thesis is divided into three parts.

Part I deals with the introduction, Historical Resume, Material and Methods, A systematic list of hosts collected and examined from Betwa and Ken rivers, and a parasite-Host list.

Part II deals with the taxonomical and morphological studies on twenty two selected trematode parasites including four metacercarial forms recovered during the study period. Their descriptions are grouped taxonomically. Mention has not been made of nematode and cestodes parasites as these were not the part of the project. Out of 18 trematodes species described, eleven have been described as new species whereas the remaining seven are redescribed in detail, furnishing further information and observations which were essential to enrich our existing knowledge on these parasites. They are known forms but majority of these form the first host and locality record from this region. In case of trematodes from Indian fishes belonging to sub family Haplorchiinae under family Heterophyidae, their validity has been discussed in detail and only two species are considered valid.

These trematode parasites belong to five families of the order Digenea.

The trematodes included in this part are -

1. A new species, Neopodocotyle betwai has been collected from the intestine of Ambasis nama (Hamilton) procured from Betwa river in the district Jhansi. It is characterised and differentiated from the other species of the genus by the presence of pars prostatica and the extension of cirrus pouch upto middle part of the ventral sucker.

2. Another new species of the genus Neopodocotyle Dayal, 1950 is N. jhansiensis which has been collected from the intestine of Rita rita (Hamilton), which also was procured from Betwa river in the district Jhansi. It is characterised by having two testes situated part from another at a distance and possessing a cirrus pouch (sac) which extends anteriorly, crosses the anterior part of right intestinal caeca.

3. Asymphylodora puntiusi n.sp. is collected from the intestine of Puntius sarana (Hamilton), The new species is characterised by the ratio of body length and breadth the posterior extent of intestinal caeca reaching upto middle of testis, the position of ovary and vitellaria, and the seminal vesicle not bipartite.

4. Phyllidistomum hardayali n.sp. has been collected from the urinary bladder of Gudusia chapra (Hamilton). The fish host was procured from Ken river in the district Banda (U.P). The new species differs from other species of the genus by possessing a new host record, ratio between body length : breadth and between oral sucker : acetabulum, position and size of ovary and in having biparite vesicula seminalis.

5. Another new species Phylodistomum phulaenei has also been collected from the urinary bladder of Rita rita (Hamilton). It is the new host record for the genus. The new species is characterised in having suckers of equal size, in having posterior body part disc like separated from much narrower anterior portion and in having ovary anterior to testes.

6. A redescription of Phylodistomum tripathi Motwani and Srivastava, 1961 is given. The variations met within the species are discussed. It forms the first host and locality record from this region.

7. Gorgotrema barbius Dayal, 1938 has been redescribed. The species was collected from the kidney of Barbius bola (Hamilton). The distinguished characters of the species are - (1) body flat, divided into an anterior elongated neck-like portion and a posterior broad circular portion,

(2) long oesophagus, broad intestinal caeca (3) tubular excretory bladder with lateral branches (4) genital opening anterior to intestinal bifurcation (5) testes follicular, in large numbers, scattered in anterior half of body, and (6) uterine coil mostly intercaecal.

8. Bucephalus bundelkhandi n.sp. has been described. It was collected from the small intestine of Corica soborna (Hamilton). The new form has an entirely different disposition of testes and structure of the tentacles.

9. Two new species of the genus Bucephalopsis (Diesing, 1855) Nicoll, 1914 namely B. bundeli and B. ramalingami have been described. Both the species have been collected from the stomach of Xenontodon cancila (Hamilton). B. bundeli n.sp. is characterised by having a collar like constriction, position of gonads in prepharyngeal zone on same side, parallel testes on same side of intestinal and parallel with intestine. B. ramalingami n.sp. is differentiated from other species of the genus in the position of ovary being lateral to anterior testis and in line with intestinal sac, in position of ootype being immediately anterior to posterior testes.

10. A redescription of Bucephalopsis gaurai Verma, 1936 is given. The species was collected from the intestine of Pseudeutropicus garua (Hamilton). It has been observed that there is great variability in the position of internal organs and considerable variations in the dimensions of the organs. All these characters are considered the intra specific variations. It forms the first host and locality record from this region.

11. Neobucephalopsis chauhani n.sp. has been collected from the small intestine of Clupiosoma garua. The fish host was procured from Betwa river in the district Lalitpur. The new species bears a distinct identity in having aspinose skin; ratio between body length and breadth and ratio between anterior and posterior testis; sacculated intestine with a characteristic annulated appearance relatively more cephalad position of the ovary and short size of cirrus sac etc.

12. Genorchopsis jaini n.sp. has been collected from the stomach of Channa punctatus (Bloch) and described. The new species differs from all the known species of the genus in the possession of a well developed receptaculum seminis and in having genital pore close behind the pharynx.

13. Genarchopsis goppo (Tubangui) Ozaki, 1925 is redescribed, The various variations met within the worms and validity of various species have been discussed. The species has been collected from Channa punctatus (Bloch).

14. A new species of an amphistomatous parasite, Caballeroia chauhani is described. It was collected from the intestine of Macrognathus aculeatus (Bloch). The species is described alongwith a review of the status of the genus and its existing species. The new species is unique in possessing an oesophageal bulb, prominent genital sucker and posteriorly contiguous vitelline follicles.

The present specimen forms the new host and locality record from this region.

15. A redescription of Astiotrema reniferum (Looss, 1898) Stossich, 1904 is given. The worms were collected from the intestine of Glyptothorax telchitta (Hamilton). The specimens collected bear certain interesting features which are usually not present in the worms of this species. These features are - possession of spines on body wall, absence of prepharynx and S-shaped vesicula seminalis, such features are described, illustrated and discussed. They are considered only intraspecific variations. It forms the new host and locality record from the Bundelkhand region.

16. From a study of numerous specimens of worms belonging to sub family Haplorchiinae under the family Heterophiydae studies from five species of Indian siluroid fishes, the twelve species have been described so far under Haplorchis, Monorchotrema, Pseudohaplorchis and Haplorchoides. The only criterion of taxonomic importance in addition to the body shape is the armature of rodlets carried by acetabulum embedded in the ventrogenital complex. In the present study the validity of certain characters met within the various species belonging to different genera have been discussed. Accordingly, only two species of the genus Haplorchoides viz. H. attenuatus and H. piscicola, are considered the valid while the remaining species are synonymised with these two species.

A revised description for the two species considered valid is given.

Part III deals with the description of four metacercarial forms recovered from the different fishes in cyst form. It includes -

1. Bucephalus prasadi n.sp. is described. The metacercariae of this new species were recovered from two specimens Eutropiichthys vacha (Hamilton). A brief review of various reports on the genus Bucephalus is made.

Detailed morphological description with special reference to excretory system of the species is given. Additionally, experimental infection to piscine and mammalian hosts is also attempted to assess the invasive capability of the new species.

2. A strigeid metaccrcaria, Diplostomulum lalitpurensis n.sp. is described. It has been collected from the body cavity, around the heart of Silonia silondia (Hamilton). Its chief characteristics are the presence of aspinose cuticle, non pigmented character of its cysts, nearly equal size of the fore and hind body and absence of an oesophagus.

3. Prohemistomulum umapatii n.sp., another strigeied metacercaria found attached with the body muscles of Badis badis (Hamilton), is described. This larva differs from all known larvae of group Prohemistomulum ciurea, 1933 on account of its shape and arrangement of genital rudiments.

4. The metacercaria of Isoparorchis hypselobagri (Billet, 1898) Odhner, 1927, has been recorded from the body cavity of Mystus vittatus (Bloch). It is described. This metacercaria has been reported from various fish species in India and Japan. It is characterised by

the presence of thick cuticle on body, intestinal caeca long and serpentine, and acetabulum large than oral sucker. It forms a new host and locality record from this region.

In the end a list giving the explanation of 20 plates including 49 figures is given. Twenty plates containing 49 figures are added. Further, a brief 'summary' of the work done and included in the thesis is also given in the end. The selected references of the literature cited are also given.

The present thesis extends over 177 pages and is illustrated with twenty plates containing 49 camera lucida diagrams of the twenty two trematode species described including four larval trematodes (metacercarial forms).

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